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Commercial Fisheries Management
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Harvests, Escapements, Migratory Patterns, and Survival of Coho Salmon in Southeast Alaska Based on Coded Wire Tagging, 1991–1992

by

Leon D. Shaul

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ABSTRACT

Wild juvenile coho salmon *Oncorhynchus kisutch* were coded wire tagged in three Southeast Alaska streams: Berners River, Ford Arm Lake, and Hugh Smith Lake. Returning adults were enumerated and sampled to estimate total escapement, fishery contribution, removal rates, migratory patterns, age structure, smolt migrations, and survival rates. The primary purpose of the program was to index fishery harvest rates and patterns and to determine factors affecting adult production.

Estimated 1991 harvest rates for the three indicator stocks were 67% for the Berners River, 54% for Ford Arm Lake, and 68% for Hugh Smith Lake. Harvest rates for the two northern stocks were slightly lower than the 1982–1991 average, whereas the estimate for Hugh Smith Lake was up slightly. Harvest rates by the Alaska troll fishery were about average for Ford Arm Lake (53%) and Hugh Smith Lake (37%) stocks, but only 18% of the Berners River stock was harvested, compared with an average of 44% for all years since 1982. The low troll harvest rate for the Berners River stock in 1991 appeared to be directly related to late run timing. The run migrated 2–3 weeks late and peaked during or after the last week of the troll fishery. Total run estimates for the three stocks were 17–53% (average 35%) above the 1982–1991 average. Survival rates were high for smolts that migrated from Berners River (24.8%) and Hugh Smith Lake (17.4%) in 1990 and returned in 1991.

KEY WORDS: Coho salmon, coded wire tag, indicator stock, migration patterns, migratory timing, harvest rate, Southeast Alaska

INTRODUCTION

The coho salmon *Oncorhynchus kisutch* is an important species to commercial, sport, and subsistence fisheries in Southeast Alaska. During 1982 to 1991, the annual commercial catch averaged 2.28 million fish and ranged from 1.07 to 3.32 million (ADF&G, integrated fishery database). Commercial fisheries have accounted for the vast majority of the total harvest; sport and subsistence fisheries have taken only about 3%.

The majority of the coho salmon harvested in Southeast Alaska are produced in over 3,000 local streams. Important contributions are also made by the Canadian portions of three major transboundary rivers (Stikine, Taku and Alsek) and by streams along the British Columbia coast. Management of fisheries for coho salmon in Southeast Alaska is complicated by the scattered distribution of the resource and by mixing of stocks. Effective management requires an understanding of the stock migratory characteristics, status, productivity, harvest rates, and fishery contributions.

To better understand wild coho stock migrations and fisheries impacts, a juvenile/smolt marking program was initiated in 1972. In these early studies, fish were marked with fluorescent pigment (Gray et al. 1978); coded wire tagging equipment was employed beginning in 1976. Through 1991, wild coho salmon were marked in 24 systems throughout the main part of Southeast Alaska and 5 systems near Yakutat. Earlier studies focused on characterizing the rates and time-area distributions of the harvest of stocks from different areas of the region (Shaul et al. 1991). As more of this information has become available, program emphasis has shifted to long-term research on selected indicator stocks that represent a larger group of stocks. In addition to providing additional information on harvest rates and patterns, these ongoing studies are directed at providing data useful in evaluating escapement goals and developing models to predict abundance. Since 1982, the wild indicator stocks have been the Berners River and Auke Creek north of Juneau, Ford Arm Lake on the outer coast, and Hugh Smith Lake south of Ketchikan (Figure 1).

This report includes a summary and analysis of tag release and recovery data for the Berners River, Ford Arm Lake and Hugh Smith Lake, the three indicator stocks under study by the Alaska Department of Fish and Game (ADF&G), Commercial Fisheries Division during the period from 1 July 1991 to 30 June 1992. Studies at Auke Creek were funded jointly by the ADF&G, Division of Sport Fish, and the National Marine Fisheries Service and are reported by Elliott and Sterritt (1991).

METHODS

Smolt and Presmolt Tagging

Migrating coho salmon smolts were tagged at Hugh Smith Lake and the Berners River from April to June 1992. Presmolts were tagged at Ford Arm Lake in July 1991. The majority of surviving fish that were tagged as age-1 rearing juveniles were expected to return as adults 2 years later, whereas those tagged as smolts were expected to return to the fisheries and spawning grounds after 1 year at sea.

Emigrating smolts were captured for tagging at Hugh Smith Lake with a smolt weir installed at the outlet of the lake. Smolts in the Berners River were captured at beaver dams using trough traps (design described by Elliott 1992). Wire-mesh minnow traps baited with salmon roe were used to capture age-1 and older juveniles at Ford Arm Lake. Approximately 100 traps were set and checked twice daily. Traps were moved frequently to maintain the highest possible catch rates. Prior to being tagged, juveniles were held in pens for a period not exceeding 3 d or until a total of 1,000–4,000 were captured. Gray and Marriott (1986) describe the minnow trapping method in detail. Emigrating smolts were tagged and released daily. A description of the coded wire tagging technique under field conditions is found in Koerner (1977).

Targets of 600 samples at Hugh Smith Lake and 850 samples at the Berners River were taken for age and length: 10% of the daily catch was sampled up to a daily maximum of 50 fish. Five to ten scales were taken from the preferred area: i.e., the left side of the fish approximately two rows above the lateral line where crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). The scales were removed with a surgical scalpel and distributed separately across one of four quadrants on a glass microscope slide. Samples from four fish were placed on each slide which was labeled with fish numbers and lengths. Another slide was then fastened over it with clear tape to protect the scales. All smolts that were sampled for scales were measured from snout to fork to the nearest millimeter.

Tag Recovery from Fisheries

Commercial catch sampling for coho salmon with coded wire tags was conducted by ADF&G sampling personnel stationed at fish processors and buying stations located throughout the region. The samplers watched for adipose clipped coho salmon during off-loading and sorting operations. Skippers of fishing vessels and tenders were interviewed to determine the districts they had fished (Appendix A.1). The heads of all adipose fin-clipped fish were sent to the ADF&G, Coded wire Tag Laboratory for tag removal and decoding. Four Quadrants (Appendix A.2) were used in expanding random recoveries from the troll fishery, whereas recoveries from net and trap fisheries were expanded by district. Statistical weeks extending from Sunday through Saturday were used for expanding net and trap recoveries. Troll fishery recoveries were expanded (1) for open periods for estimating total contribution, (2) by statistical week and

quadrant for analyzing migratory timing, and (3) by fishing period and PMFC area for analyzing harvest distribution. Randomly recovered tags were expanded by the inverse of the proportion of the catch that was sampled within an area, gear type, and weekly or period stratum; adjustments were made to account for lost samples (Clark and Bernard 1987). An adjustment for lost samples was made by multiplying expansions by the inverse of the proportion of heads and tags lost.

The ADF&G, Sport Fish Division conducted a creel census and survey of the Juneau and Ketchikan marine recreational fisheries (Suchanek and Bingham 1992). Tags recovered from random samples were expanded over biweekly strata that contained several stratifications: (1) weekdays versus weekends and holidays, (2) mornings versus afternoons, and (3) low-use versus heavy-use docks. Tags caught in derbies were expanded separately.

Sampling of British Columbia coastal fisheries and reporting of coded wire tag recoveries was conducted by the Canada Department of Fisheries and Oceans (CDFO).

Escapement Enumeration and Sampling

Coho salmon escapements were enumerated or estimated at Ford Arm Lake, Hugh Smith Lake and the Berners River. As many fish as possible were examined for adipose clips at weir sites and during sampling operations on the spawning grounds.

Age-length-sex samples were taken from a target sample of 500 adult fish captured from the Berners River using a beach seine and from 600 fish each from the migrations at the Ford Arm and Hugh Smith weirs. Each fish that was sampled for age-length-sex was placed in a padded measuring trough and measured to the nearest millimeter (mid-eye-to-tail fork length). Fish sampled at the weirs were anesthetized in a solution of MS-222, but fish sampled at the Berners River were not. The length and sex were recorded. Fish were classified as adults (age-1) or jacks (age-0) based on their sex and length. In 1991, males were classified as jacks if they were under 500 mm at Ford Arm Lake and under 450 mm at Hugh Smith Lake and the Berners River. Four scales were taken from the preferred area (INPFC 1963). Scales were mounted on gum cards and impressions later made in cellulose acetate (Clutter and Whitesel 1956).

Berners River Surveys

The upper Berners River and tributaries were surveyed by foot and helicopter during an 8-d trip in late October. The survey area included all locations where fish have been found previously in thorough surveys of the system. The area was covered on two sequential days: from camp to the headwaters on the first day and from camp downstream on the second day. I planned to conduct a second complete survey later in the trip if there was evidence that more fish had moved into the upper river, based on observations of water conditions and movement of fish. All side tributaries throughout the survey area were examined for fish. The surveys were conducted during low water conditions for optimum visibility

and to minimize movement of fish between sections in the interval between upstream and downstream surveys.

The Berners River surveys were conducted by the same observer that had surveyed the system during the previous 9 years. The observer wore polarized sunglasses. In headwaters sections and tributaries, the observer walked upstream along the bank or in the stream channel, if necessary, to avoid dense vegetation. The observer looked ahead and counted fish individually as they darted downstream past the observer or under banks or logs. Rocks were thrown into suspected hiding areas to drive fish out to be counted. In some small tributaries with overhanging root systems, the observer probed under banks to drive hiding fish out to be counted. Pools with larger schools of over 100 fish were counted repeatedly from different angles and directions until the observer was satisfied with the count, which was typically the average of several counts. The observer moved quietly and slowly along the bank above the fish and attempted to count without disturbing them. Counting larger schools was often done by tens, or by tens and hundreds for the largest schools of 1,000–2,000.

Although infrequent, dead fish or fresh parts (jaws or pyloric caeca) found that could be identified as individual coho salmon were included in the count. Species identification was not considered to be a problem because coho salmon were the only salmon species present in the area during late October, although schools of Dolly Varden were present in some areas.

Helicopter surveys of the lower river were conducted from an altitude of 30-50 m with the sun at the observer's back. The helicopter was first held stationary off to the side of the pool, so that prop wash on the water did not obscure visibility and so that the fish remained somewhat stationary and did not stir up bottom sediment. The helicopter sometimes moved past the fish or in a circle around them if the observer needed to see the fish move to confirm that he had observed all of them.

The trip was timed so that little if any spawning had occurred before the survey count and the vast majority of the escapement had entered the system. Some fish were just beginning to enter spawning areas in the headwater, and small tributaries, but most were holding in clear pools below spawning areas. The 10-d trip was typically long enough to avoid unfavorable survey conditions due to high water.

Fish were captured with a 14-m beach seine for sampling for coded wire tags and age-length-sex data. The sampling target for tagged fish was at least 1,500 fish for escapements of more than 6,000 spawners or 25% of the total survey count for a smaller escapement. The beach seine was deployed in pools by a three-person crew. Fish captured in the beach seine were marked with a partial dorsal clip using wire cutters and examined for a missing adipose fin. If the fish was unmarked, it was included in the tally and released. Adipose-clipped fish were examined with a magnetic field detector to determine the presence of a tag. If the fish registered a positive signal, it was released and recorded as having a tag. If a coded wire tag was not detected from an adipose-clipped fish, the fish was sacrificed, and its head was marked with a jaw tag and sent to the tag lab for further verification; if a tag was detected, a recapture was noted and the fish was released.

Ford Arm Lake Weir

A wooden tripod and metal picket weir, approximately 43 m long, was operated at the outlet of Ford Arm Lake from August 10 through October 23. Spawning usually begins below the weir in mid- to late October. Weekly surveys were conducted below the weir, when water conditions permitted, until the weir was removed. Subsequent cumulative weir counts were subtracted from each survey count; the greatest difference between these numbers was recorded as the number of fish remaining downstream when the weir was removed.

In some years, the weir has become ineffective for short periods due to water flowing over the top or because of holes made by bears (Shaul et al. 1985, 1986). Water flowing over the top was resolved by installing a railing with a hardware cloth extension along the top of the weir to maintain a complete barrier during flood conditions. However, minor problems with the integrity of the weir have occurred in some recent years when bears have opened holes in the wire mesh during critical high-water periods. This has necessitated tagging and recovery to estimate the escapement.

All healthy coho salmon that passed through the weir were captured in a trap and subsequently sampled for coded wire tags and marked with a partial dorsal clip. The posterior three rays of the dorsal fin were sheared with wire cutters approximately 1 cm above the fish's back. In 1982 and 1983, fish were tagged with numbered Floy anchor tags (Shaul et al. 1985, 1986). However, data from those years indicated virtually complete intermixing of marked fish between tagging and recovery and that a single stratum estimate (Chapman 1951) should be unbiased. In 1982, elapsed time between tagging at the weir and live recovery in the inlet streams ranged from 1–78 d (Shaul et al. 1985). Therefore, application of numbered tags was discontinued because of the expense and high tag-loss rates. The dorsal clip was been employed as the primary mark in more recent years because it was easier and less expensive to apply. It was unencumbered by tag loss in living samples, which accounted for nearly all recovery samples at Ford Arm Lake.

Mark recovery sampling was initiated on October 11. All fish that passed the weir after recovery sampling began were marked with a left opercular punch rather than a dorsal clip so that they could be distinguished if recaptured. They were also excluded from the mark-recapture estimate. Recovery sampling was conducted primarily with sport spinning gear and, in some cases, beach seines and dip nets. Two rods were fished at locations around the lake. Fish that were captured were marked with a right opercular punch and sampling was conducted without replacement until 50 fish were captured. If more than one fish without a dorsal clip or left opercular punch was captured in this sample, sampling effort was continued until the weir was removed in late October.

If no fish were found to have passed the weir uncounted, the escapement estimate of age-1 fish included the sum of the following: (1) total weir count including all weir mortalities and fish that were sacrificed for samples (2) the greatest difference between a downstream survey count and the weir count after the survey was made and (3) the sum of pre-spawning mortalities observed in downstream surveys. If fish were found to have passed the weir uncounted, the gross estimate included the sum of the following: (1) Chapman estimate of the population above the weir when recovery sampling was initiated, (2) fish

counted upstream past the weir and marked with a left opercular punch after recovery sampling was initiated, (3) upstream migrant mortalities that occurred at the weir including fish that died in the trap or were killed by bears and fish that were sacrificed as samples, (4) unspawned wash-ups on the weir (assumed to be handling mortalities and not included in the Chapman estimate), (5) the greatest difference between a downstream survey count and the weir count after the survey was made, and (6) the sum of pre-spawning mortalities observed in downstream surveys. Estimates of gross escapement were used in calculating total return, harvest rates, and juvenile-adult survival rates. Net escapement is the gross escapement estimate minus pre-spawning mortalities that are human-inflicted (trap mortalities, bear kills at the weir, coded wire tag samples, and unspawned wash-ups). Net escapement is used to estimate brood year escapement for spawner-recruit analysis.

The coho salmon escapement at Ford Arm Lake was sampled for coded wire tags. All fish that were counted past the weir were captured in the trap and examined for the presence of an adipose fin. Fish that had clipped adipose fins were examined with a magnetic field detector to determine whether or not a tag was present. Marked fish that did not register a positive signal, passing both directions through the detector, were sacrificed and the heads are sent to the ADF&G coded wire tag lab in Juneau for further verification. An individual record was made of each fish that passed the weir including whether it was an adult (age .1) or jack (age .0), whether or not it had an adipose clip and whether or not it registered a positive signal on the detector if adipose clipped. Age-length-sex samples were recorded on the same form. Each adipose clipped fish that did not register a signal on the magnetic field detector was sacrificed, a numbered cinch strap was attached to the head, and the number was recorded on the form.

At Ford Arm Lake, males under 460 mm in length were classified as jacks; other fish were classified as adults. There was a chance of misclassifying a very small number of fish because of a small overlap between size distributions of the two ocean age classes. Not all jacks were enumerated because some were small enough to pass between the pickets.

Hugh Smith Lake Weir

The Hugh Smith Lake weir was operated from early June through October 11 when it's integrity was breached by a flood. All healthy adult coho salmon that passed through the weir were captured in a trap, sampled for coded wire tags, and marked with a partial dorsal clip.

Recovery sampling was initiated during October 17–23 using sport gear in the lake near the inlet streams. A second trip was conducted during November 20–22 when several methods of capture were employed including beach seine, dip net, hand, gillnet and sport rod. All fish that were sampled were marked with a single left opercular punch and released. All marks (adipose clip, dorsal clip, opercular punch) on recovery samples were recorded and the fish were classified as adults or jacks.

The coho salmon escapement at Hugh Smith Lake was classified by ocean age and sampled for coded wire tags using the same techniques employed at Ford Arm Lake. Most fish that were counted past the weir were captured in a trap and examined for the presence of an adipose fin.

Analysis of Tag Recovery Data

The proportion of fish in the escapement of an indicator stock that were coded wire tagged (Θ_i) was estimated by

$$\Theta_i = \left(\frac{m_1}{s}\right)\left(\frac{t}{m_2}\right), \quad (1)$$

where:

S = number of fish in the escapement sampled for adipose clips,

m_1 = number of fish in sample (S) that had adipose clips,

m_2 = number of adipose clips in the escapement sampled for tags,

t = number of adipose-clipped fish in the escapement that were sampled for tags and were found to have tags.

The total number of coded wire tagged fish in the indicator stock escapement (E) was estimated by multiplying the stock's total estimated escapement (N) by the proportion tagged (Θ_i).

$$E = N \Theta_i. \quad (2)$$

Harvest by Gear Type and Escapement

Fishery contribution estimates, or the number of indicator stock fish caught (C) in fishery i , was estimated by:

$$C_i = \frac{F_i}{\Theta_i}, \quad (3)$$

where F_i was the estimated number of tagged fish harvested (expanded sum of random fishery recoveries) in fishery i .

The total run size for an indicator stock (X) was estimated by adding the sum of the estimated catch of the stock in all fisheries and the escapement.

$$X = \sum C_i + N. \quad (4)$$

Harvest Rates

The harvest rate (H) for an indicator stock in fishery i was estimated as follows:

$$H_i = \frac{F_i}{\sum F_i + E}, \quad (5)$$

where the denominator is the total number of tagged adult returns for that stock. The overall harvest rate for an indicator stock by all fisheries was estimated as follows:

$$\sum H_i = \frac{\sum F_i}{\sum F_i + E}, \quad (6)$$

Where the numerator is the total number of tagged stock i fish caught in all fisheries.

Removal Rates

The *removal rate* is defined as the total harvest within a specific fishery divided by the total number of fish available within that fishery, which, for this analysis was considered to be the estimated total return (catch and escapement) minus fish harvested in preceding fisheries. Therefore, it was necessary to assume a direction of migration. In this analysis, it was assumed that returning coho salmon migrated by the most direct route(s) from the open ocean toward their system of origin and all pass through the fishing areas. Defining T_2 as the number of tagged fish available to the first fishery and F_1 as the harvest of tagged fish by fishery i , the removal rate (R) by the first fishery was estimated as follows:

$$R_1 = \frac{F_1}{T_2}. \quad (7)$$

For subsequent fisheries where $i > 1$, R_i was estimated as follows:

$$R_i = \frac{F_i}{T_2 \prod_{j=1}^L (1-H_j)}, \quad (8)$$

where $L = i-1$.

Removal rates were estimated by fishery for the Berners River stock and by area for the Hugh Smith Lake stock. Total harvest rate estimates were generated for the Ford Arm Lake stock, but removal rate estimates for individual areas and fisheries were not made because most of the catch occurred in outside districts lacking a clearly defined migration through sequential fisheries. The Ford Arm Lake stock was believed to be harvested simultaneously by all fisheries.

Distribution of Harvests

Distribution of harvests for tagged stocks was examined by fishery and gear type. The harvest distribution for tagged stocks provided an indicator of harvest distribution for untagged stocks. Expanded tag recoveries of a stock in each fishery (F_i) were divided by the sum of expanded fishery recoveries in all fisheries (ΣF_i). Tag recoveries from the Alaska troll fishery were expanded by PMFC area (Appendix A.2) and fishing period, and recoveries from the net and trap fisheries were expanded by district and statistical week. In addition, the distribution of the Southeast Alaska troll catch of the three stocks was estimated using quadrant-period strata.

Migratory Timing

The migratory timing of the three stocks in the troll fishing districts was estimated from the distribution of the weekly harvest of tagged fish. Troll fishery tag recoveries were expanded to total catch by quadrant and week. The weekly proportion of the total troll catch of each stock was estimated for each year when data were available. Expanded weekly recoveries were divided by the sum of expanded recoveries from throughout the season to estimate weekly proportions of total catch. These estimates were based on the dates of landing of tagged fish at fishing ports. Because the average trip length for a troll vessel is about 4-6 d, the average time of capture of landed fish probably occurred 2-3 d previously.

Survival Rates

Survival rates for smolts to adults comprising the run were estimated for coho salmon that migrated from Hugh Smith Lake from 1983 to 1990 and from the Berners River in 1989 and 1990. Survival was also estimated for presmolts tagged in the Berners River and Ford Arm Lake during 1980, 1981 and 1983 to 1988.

It was assumed that all marked adults returning to a system had been tagged there as juveniles or smolts and that naturally missing adipose fins were negligible; i.e., all untagged adipose-clipped fish were assumed to have shed their tags. A sample of adipose-clipped fish (m_2) was drawn from the escapement and sampled for coded wire tags, of which t fish were found to be tagged. The survival rate, S , from the time of tagging (smolt or presmolt) to the age .1 adult stage was estimated as follows:

$$(S) = \frac{(\sum F_i + E)(\frac{m_2}{t})}{T_1}, \quad (9)$$

where:

m_2 = number of adipose-clipped fish in the escapement that were examined for tags,

t = number of sampled adipose-clipped fish in the escapement that contained tags, and

T_1 = number of smolts or juveniles tagged.

Tag retention was assumed to be constant for different tagging years in a single return year. However, different tag retention rates may occur in releases from different years, and this could cause small errors in the estimates.

Smolt Migration Estimates

Smolt migration estimates from Hugh Smith Lake between 1983 and 1990 and the Berners River in 1989 and 1990 were made using a Chapman estimate (Chapman 1951). The number marked (M) was the number of smolts that were adipose-clipped and released as they migrated from the system in year i , regardless of whether or not they retained their coded wire tags. The recovery sample (C) was the sum of the number of age-.0 fish sampled for adipose clips at the weir in year i and the number of age-.1 fish sampled for adipose clips at the weir in year $i+1$. The number of marks recovered (R) was the number of adipose-clipped fish observed in the recovery sample.

RESULTS

Smolts and Presmolts Tagged

Ford Arm Lake Presmolts

A total of 9,506 presmolt coho salmon captured in 1,796 minnow trap sets at Ford Arm Lake during July 5–16, 1991, were coded wire tagged (Table 1). Of those, 2,126 were 65–79 mm, 5,691 were 80–100 mm, and 1,689 were >100 mm fork length. The average catch was 5.3 coho salmon 65 mm and larger per trap.

Berners River Smolts

Between May 7 and June 9, 1992, 54,426 coho smolts were captured in two trough traps operated in each of two beaver ponds on the lower Berners River. Of the total number captured, 37,976 came from the pond on the west side of the valley, and the remaining 16,450 came from the pond on the east side. The number captured under-represented the actual smolt production of the two ponds because fish were able to pass over the dam during high water without going through the smolt traps and because some smolts probably passed before and after the traps were operated. Only 45 smolts were captured on the first day of full operation; however, 808 were captured on the last day. The daily catch peaked on May 25, when 5,602 smolts were captured in spite of high water. Of the total number captured, 52,406 were coded wire tagged (Table 2).

The greater catch from these ponds in 1992 compared with 1990 and 1991 may have resulted from more favorable water conditions with fewer opportunities for fish to pass around the traps. The estimated total smolt run from the system will not be known until returning adults are sampled on the spawning grounds in 1993.

Hugh Smith Lake Smolts

The Hugh Smith smolt weir was installed during April 28–29, 1992, and became fully operational on April 30. In previous years, few if any, fish were caught before May 1. However, in 1992 run timing appeared to be earlier: 54 fish were captured on April 30, 294 on May 1 and 458 on May 2. The weir became inoperational for 1 d because of flooding on May 3. The peak of the run appeared to occur at that time. Only 5,519 coho smolts were captured and tagged before the weir was removed on May 29 (Table 3).

Escapement Enumeration and Sampling

Berners River Surveys

During October 21–28, the upper Berners River was surveyed by foot and helicopter and the escapement was sampled. Conditions were excellent with low, clear water during the entire trip. A total of 11,530 adult coho salmon were counted, of which 1,694 were captured and examined for adipose clips. Of the sampled fish, 303 had adipose clips, 298 were sampled for coded wire tags, and 296 of these had tags. The heads were taken from the two fish that did not register a tag and the absence of a tag in those fish was confirmed at the tag lab. Tag recoveries from the Berners River were expanded to a total estimate of 2,048 tags (17.8%) in the total escapement.

Four scales each were taken from 628 adults in a random sample, of which at least one scale from 581 (92.5%) adults was ageable. Of the fish with ageable scales, 212 (36.5%) were determined to be age 1.1, 362 (62.3%) were determined to be age 2.1, and 7 (1.2%) were determined to be age 3.1. In addition, one jack was included in the sample and was determined to be age 3.0.

Ford Arm Lake Weir

The Ford Arm Lake Weir was operated during August 10 – October 23. A total of 2,254 adults and 226 jacks were passed during the period of operation. Ten fish were passed on August 12 as soon as the trap was operational, which indicated that some might have passed before the weir was installed. Otherwise, the weir appeared to be fish-tight throughout the period. All fish that were passed through October 10 were marked with a dorsal clip; while those that passed after that date were marked with an opercular punch. Mark-recapture sampling was initiated on October 11 using sport fishing gear at several locations around the lake, and 124 age-1 fish were captured. Of these, 106 had dorsal clips, 5 had an opercular punch, and 7 had no mark. A Peterson estimate of the number that passed live during August 10 – October 10 was 2,221 ($M=1,980$, $C=119$, $R=106$). Adding 252 fish from the weir count during October 11–23, 10 dead unspawned fish observed downstream during pink salmon stream surveys, 15 unspawned weir wash-ups through October 10 (assumed to be handling mortalities), 7 fish sacrificed for coded wire tag samples through October 10, and 271 fish counted downstream of the weir when it was pulled on October 17 (minus 15 fish that passed the weir site after that date) brought the estimated gross escapement of age-1 fish to 2,761 fish (95% C.I. = 2,627-2,895). This number was used for run reconstruction and harvest rate analysis. The net escapement was 2,737 fish, i.e., the gross escapement minus 24 assumed total sampling mortalities (16 unspawned carcasses on the weir and 8 fish sacrificed for coded wire tag samples).

A total of 2,275 fish were sampled for adipose clips of which 499 were marked. Of those, 494 adults were sampled with a field detector and 485 registered a tag-present signal. Heads were taken from eight of the nine fish that did not register signals, and all were confirmed to not have tags. Tag retention was estimated at 98.7%. There were an estimated 595 (21.5%) tagged adults in the gross escapement to Ford Arm Lake. Of the 226 jacks counted at the weir, 29 were adipose clipped.

Based on a sample of ageable scales from 440 adult coho salmon, 4.3% were age 1.1, 70.4% were age 2.1, 24.9% were age 3.1, and 0.4% were age 4.1. Based on a sample of 41 jacks, 38% were age 2.0, 57% were age 3.0, and 5% were age 4.0.

Hugh Smith Lake Weir

The Hugh Smith Lake weir was operated from early June through October 11, when it was inundated by water and impacted by approximately 35 logs. A total of 1,431 age-1 fish and 63 age-0 jacks were counted during the period of operation. A total of 1,427 fish were marked at the weir with dorsal clips. Tag recovery sampling was conducted during October 17–23, and 31 adults were captured with sport fishing gear in the upper lake. Of those, 26 had dorsal clips and 5 did not. A second mark recovery trip was made during November 20–22 when additional 159 adults were captured with a seine, dipnet, sport gear, a gillnet and by hand. Of the second sample, 139 were dorsal clipped and 20 were not. Based on the marking and recovery data, the total escapement was estimated at 1,647 (95% C.I. = 1,562–1,732) including 5 weir mortalities. However, a review of numbered anchor tag data from the 1982 coho escapement at Hugh Smith Lake (Shaul et al. 1985) indicated that this was probably an underestimate because (1) the earlier data showed a positive relationship, albeit weak, between tagging and recovery, and (2) because nearly all of the unmarked fish in 1991 were assumed to have passed at very late in the run. If a second recovery trip had been made in early January, I believe that the proportion marked would have been substantially lower.

Therefore, the average cumulative proportion was used to estimate the 1991 escapement. The weir remained fish-tight over the duration of the run in 6 previous years (1982, 1983, 1984, 1985, 1989 and 1990). The average proportion of the gross escapement counted through October 11 was 0.784 (range 0.635–0.872). The 1991 count of 1,432 fish through October 11 was divided by 0.784 to estimate the total escapement (1,826) and the variance of the historical average proportion was used to estimate 95% confidence limits (1,511–2,304).

A total of 1,456 age-1 adults were examined for adipose clips, of which 495 were marked. Of the marked fish, 299 were examined with the field detector; 298 registered a tag-present signal and 1 did not (later verified not to have a tag). An estimated 619 (33.9%) adults in the escapement had coded wire tags. Tag retention was estimated at 99.7%. Of 74 jacks sampled for marks at the weir and during recovery work, 46 (62.2%) had adipose clips.

Based on a sample of ageable scales from 563 adult coho salmon, 8.0% were age 1.1, 82.4% were age 2.1, 9.2% were age 3.1, and 0.4% were age 4.1. Based on a sample of 20 jacks, 15% were age 2.0, 70% were age 3.0, and 15% were age 4.0.

Harvest by Gear Type and Escapement

The estimated 1991 run of 35,159 coho salmon to the Berners River and the escapement of 11,530 were the largest recorded for that system (Table 4). During 1982, 1983, and 1985-1991, the total return to the Berners River averaged an estimated 25,730 fish (range 14,058–35,159). In spite of the strong return, the estimated 1991 contribution to the Alaska troll fishery of 6,416 fish was well below the average of 11,058. Conversely, the 1991 contribution of 16,518 to the drift gillnet harvest was far greater than the average of 7,606. Of the drift gillnet contribution, the District 115 fishery (Lynn Canal) took 16,366 fish, whereas 114 were taken in District 111, 30 in District 106, and 8 in Prince William Sound. An estimated 578 fish were taken by purse seiners, and 117 in the marine sport fishery. The Berners River appears to typically contribute few fish to those fisheries; 1982-1991 catches have averaged 123 fish (0.4% of run) by purse seine gear and 128 (0.5% of run) by marine sport gear. The total harvest in 1991 was estimated at 23,629, and the overall harvest rate was estimated at 67.2%. The average harvest rate during 1982 through 1983 and 1985 through 1991 was estimated at 74.4%. The troll fishery harvested only an estimated 18.3% of the run in 1991, which was the lowest troll harvest rate on record (Table 4). Conversely, the drift gillnet fisheries took the highest percentage on record (47.0%). Harvest rates for the Berners River were probably overestimated because escapement estimates are based on a peak survey count rather than a total weir count or mark-recapture estimate.

The estimated 1991 total run to Ford Arm Lake on the outer coast of Chichagof Island of 6,023 fish was higher than the 1982–1983 and 1985–1991 average of 5,167 (Table 5). The total harvest and overall harvest rate were estimated at 3,262 and 54.2%. The troll fishery harvest of 3,208 was higher than the average of 2,734, but the troll harvest rate of 53.3% was very close to the 1982–1991 average of 52.5%. As usual, the purse seine fishery took only a small percentage (44 fish; 0.7%). In 1991 a tagged Ford Arm Lake fish was recovered from a drift gillnet fishery for the first time; the estimated contribution was 10 fish (0.2%) to the drift gillnet fishery in Prince William Sound. The gross escapement of 2,761 age-1 fish to Ford Arm Lake was the second highest recorded.

The 1991 total return to Hugh Smith Lake was estimated at 5,731 fish (Table 6). This estimate was higher than the 1982–1991 average of 3,749 and second only to the estimated return of 6,096 in 1982. In 1991, the fisheries accounted for an estimated total catch of 3,905 fish, which was 68.1% of the total return. As was the case in the past, the harvest of Hugh Smith Lake coho salmon was distributed across a variety of fisheries. An estimated 56.4% of the run was harvested in Alaska, of which 36.7% was taken by troll gear. Other Alaska fisheries accounted for lower percentages: 15.4% by drift gillnet gear, 3.4% by purse seine gear and 0.9% by marine sport gear. An estimated 11.7% was harvested by British Columbia fisheries: 11.0% by troll gear and 0.7% by net fisheries. The 1991 overall harvest rate estimate of 68.1% for Hugh Smith Lake was low compared to estimates of 82.1% in 1989 and 81.1% in 1990. However, it was slightly higher than the 1982–1991 average of 66.4%.

Harvest rate estimates were summarized for the Alaska troll fishery and all fisheries combined (Table 7; Figures 2, 3). In both cases, average harvest rates have been relatively stable from 1982 to 1991.

Removal Rates

The 1991 combined troll and purse seine removal rate for the Berners River stock was estimated at 19.9%; this was the lowest estimate on record and less than half of the 1982–1991 average of 44.9% (Table 8). The estimated removal rate in the Juneau marine sport fishery, the second fishery on its migration route, was only 0.4%. Because of its late run timing, the Berners River run was subjected to only minor fishing pressure in purse seine and marine sport fisheries. The removal rate in the Lynn Canal (District 115) drift gillnet fishery, the last fishery entered, was 58.7%, compared to its 1982–1991 average of 52.1% (range 15.5–83.6%).

Before becoming available in inside waters of southern Southeast, coho salmon returning to Hugh Smith Lake were assumed to be harvested simultaneously in northern B.C. and the outside and intermediate districts of Southeast Alaska. In 1991 the combined removal rate estimate for Hugh Smith Lake coho salmon in northern B.C. and the outside and intermediate areas of Southeast Alaska was 41.6%, of which 29.9% was attributed to Alaska fisheries and 11.7% was attributed to northern B.C. fisheries (Table 9). The estimated removal rate in inside areas was 45.4%, whereas the estimated overall harvest rate for all fisheries averaged 68.1%.

Distribution of Harvests

The harvest of the Berners River coho salmon stock was restricted largely to northern fishing areas of Northern Outside, Central Outside, Central Intermediate, Lynn Canal and Stephens Passage) which accounted for an estimated average of 98.7% of the catch during 1982, 1983, and 1985–1991 (Table 10). Small percentages (<1% each) were taken in the Central Inside, Southern Outside, Southern Intermediate, Southern Inside and Prince William Sound Areas and northern British Columbia. In 1991 Lynn Canal was the most important single harvest area for the Berners River stock, accounting for an estimated of 69.5% of the total catch. The percentage taken in outside troll districts was very low compared with previous years; only 3.4% were harvested in the Northern Outside Area and 4.9% in the Central Outside Area. The troll fishery in the Central Intermediate Area (Icy Strait and Cross Sound) accounted for 18.1% of the total catch, which was lower than the 1982–1991 average of 26.2%.

In 1991 Ford Arm Lake coho salmon were harvested primarily along the local Central Outside Area where 83.2% of the estimated catch was taken (Table 11). Other important locations where Ford Arm Lake fish were harvested included the Northern Outside (9.3%) and Central Intermediate Areas (4.9%). In addition, minor harvests included the Southern Outside (2.0%) and Southern Intermediate (0.7%) Areas.

Hugh Smith Lake coho salmon were harvested over a relatively broad area from Yakutat to northern British Columbia (Table 12). In 1991 the most important harvest areas were the Central Outside (21.6% of the total harvest), Southern Outside (16.4%), and Southern Inside (27.0%) Areas and Northern British Columbia (18.2%). In addition to those areas, Hugh Smith Lake coho salmon were caught in Prince William Sound (0.1%) and the Northern Outside (2.9%), Central Intermediate (1.2%), Southern Intermediate (5.5%) and Central Inside (7.1%) Areas.

The harvest distribution of the Southeast Alaska troll catch of selected stocks was estimated by quadrant (Appendix A.2). In 1991, as in previous years, nearly all of the estimated troll catch of Berners River and Ford Arm Lake coho salmon occurred in the Northwest Quadrant (Table 13). Hugh Smith Lake fish were more widely distributed over the quadrants: Northwest 47.6%, Northeast 4.9%, Southwest 21.7%, and Southeast 25.8% of the total harvest.

Migratory Timing

Although available to some extent during most of the season, the Berners River stock has displayed characteristically late migratory timing in all fisheries (Shaul et al. 1991). On the average, it peaked in the troll fishery during late August through mid-September (Figure 4). However, in 1991 the Berners River run was exceptionally late (Appendix B.1); the peak troll catch occurred in the last week of the season, at least 2 weeks later than average. Total abundance may not have peaked when the troll fishery was closed on September 20.

On average, the Ford Arm Lake stock was characterized by protracted timing in the troll fishery. Significant weekly catches occurred from the first week of July through the first week of September (Figure 5). In 1991, the run appeared to peak in late July (statistical week 30; Appendix B.2).

On average, during 1982 to 1991 Hugh Smith Lake coho salmon were available to the Alaska troll fishery from late June through the end of the season on 20 September (Figure 6; Appendix B.3). They typically appear in highest abundance in troll catches in outside and northern waters from mid-July through August (Figure 7) and in the southeast quadrant from late-August through mid-September (Figure 8). In 1991 the timing of the overall troll catch of Hugh Smith Lake fish appeared to be about average in outside and northern waters (Appendix B.4), although they peaked about 2 weeks later than average in the Southeast Quadrant (Appendix B.5).

Survival Rates

The estimated survival rate for Berners River smolts that migrated to sea in 1990 and returned as adults to compose the 1991 run was 24.8% (Table 14); this excluded 1991 jacks. The only previous estimate for smolts from that system was 19.8% for smolts migrating in 1989 (Shaul *in press*).

Ford Arm Lake rearing juveniles tagged during July and August 1980–1988 have experienced high survival rates to adult return (excluding jacks) that ranged from 6.0–14.4% and averaged 9.6%. The estimate for fish tagged in 1988 that returned in 1990 and 1991 was 10.3%.

The estimated survival rate for smolts that migrated from Hugh Smith Lake in 1982 to 1990 averaged 11.4% with a range of 4.2–19.1% (Table 14). The survival rate estimate of 17.4% for 1990 smolts which returned as adults in 1991 was the third highest on record for 9 years of estimates.

Smolt Estimates

The 1990 coho smolt migration from Hugh Smith Lake was estimated at 32,925 (95% C.I. 30,709–35,141), which was close to the 1983 to 1990 average of 31,046 (Table 15). During 1983 to 1991, Hugh Smith Lake smolts were predominantly age 2.0 (average 60.5%); age 3.0 at 24.2% and age 1.0 at 14.4% were also important (Table 16). Age 4.0 and 5.0 smolts were present but uncommon. Smolt migration estimates by year of migration are shown in Table 17. The estimated smolt migration for the 1981 through 1986 brood years ranged from 23,480 to 33,351 (Table 18). The smolt estimate for the 1985 brood year (excluding age-5.0 migrants) was 24,988; the smolt estimate for the 1986 brood year (excluding age 4.0 and 5.0 migrants) was 23,480.

The 1990 estimated smolt migration from the Berners River of 141,154 fish (95% C.I. 126,272–156,036) was lower than the estimated 1989 run of 164,357 (Shaul *in press*). The age composition of the 1990 smolt migration was estimated as follows: 23.8% age 1.0, 74.3% age 2.0, and 1.8% age 3.0 (n=869).

DISCUSSION

Shaul (*in press*) expressed concern over high harvest rates for the Hugh Smith Lake stock of 82% in 1989 and 81% in 1990 compared with an average of 62% from 1982 to 1988. In 1991, however, the estimated harvest rate for the Hugh Smith Lake stock decreased again to 68%. The long-term trend in the harvest rate for that stock is still not clear. Some fisheries that harvest coho stocks in the Ketchikan area have increased while others have remained stable. Coho salmon catches in the Annette Island drift gillnet fishery and the Ketchikan marine sport fishery have increased dramatically within the past decade. However, the latter fishery harvests few Hugh Smith Lake coho salmon. The harvest rate on the Hugh Smith Lake stock by the northern British Columbia troll fishery appeared to show an increasing trend within the past 10 years, the average increasing from 6.3% in 1982–1986 to 10.9% in 1987–1991.

Stocks in Districts 101 and 102 have become the primary management concern for coho stocks in the region because the overall rate of harvest has averaged over 70% in recent years. These stocks are difficult to manage because of their distribution over a broad area that includes several mixed stock fisheries. Hatchery production has increased dramatically in this area in recent years and has probably contributed to increased fishing pressure on wild coho stocks. Therefore, further increases in coho production need careful evaluation, including the potential effects on wild stocks and on coho-directed fisheries that could require further restrictions to prevent overfishing.

The mark-recapture estimate for the escapement to Hugh Smith Lake had narrow confidence bounds (1,647; 95% C.I. 1,562–1,732) but was probably an underestimate because of violation of the assumption of equal probability of marking or recapture. All of the fish that escaped uncounted apparently passed the weir near the end of the season when it was damaged by a severe flood. However, the recovery sampling was concentrated on the earlier spawning segment which tends to spawn in Cobb Creek in

November. Later spawners are more likely to spawn in Buschmann Creek in January. The estimate of 1,826 using the average cumulative proportion was probably less biased but had a broader confidence range (1,511–2,304). This experience points to the need for multiple mark and recovery periods in order to obtain unbiased escapement estimates.

The migration of Berners River coho salmon was exceptionally late in 1991. The run may not have peaked in the main troll fishing districts until after the end of the season on September 20. Consequently, the estimated harvest rate by the troll fishery was very low (18%) compared with the average for all years (44%). The Ford Arm Lake and Hugh Smith Lake stocks have migrations that begin earlier and are more protracted. These stocks were harvested by the troll fishery at very close to average rates.

Much of the decrease in the troll harvest rate on the Berners River stock was made up by a higher drift gillnet harvest rate of 47% compared with the average of 29% for all years. Excellent marine survival of Lynn Canal stocks combined with a decreased troll harvest rate and substantial new hatchery production resulted in high catches for the drift gillnet fleet in 1991. The total Lynn Canal (District 115) drift gillnet catch of coho salmon increased to 128,365 fish from the 1981–1990 average of 68,351.

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Table 1. Number of presmolt coho salmon tagged at Ford Arm Lake by year and code, 1980-1991.

Year	Code	Number Marked
1980	4-20-21	5,925
	4-20-24	<u>444</u>
	Total	6,369
1981	4-21-23	4,914
	4-21-33	<u>2,012</u>
	Total	6,926
1983	4-23-23	3,882
1984	4-23-28	2,033
	4-24-35	<u>5,629</u>
	Total	7,662
1985	4-24-47	7,626
1986	4-23-03	10,392
1987	4-26-57	10,138
1988	4-29-22	11,108
	4-29-18	<u>1,459</u>
	Total	12,567
1989	4-29-41	11,300
1990	4-33-54	10,742
1991	4-36-38	9,506

Table 2. Number of Berners River coho salmon tagged by year, type and code, 1972-1992.

Year	Type	Code	Number Marked
1972	Presmolt	Fluorescent pigment	8,066
1976	Presmolt	4-02-15	10,817
		4-03-08	<u>526</u>
		Total	11,343
1977	Presmolt	4-16-37	380
		4-17-29	<u>10,758</u>
		Total	11,138
1980	Presmolt	4-20-15	10,145
		4-20-30	<u>780</u>
		Total	10,925
1981	Presmolt	4-19-21	7,826
1983	Presmolt	4-22-08	1,278
		4-22-43	<u>9,070</u>
		Total	10,348
1984	Presmolt	4-24-34	4,499
		4-24-36	<u>10,827</u>
		Total	15,326
1985	Presmolt	4-24-46	10,110
1986	Presmolt	4-23-05	8,740
1987	Presmolt	4-26-56	10,349
1988	Presmolt	4-29-42	9,926
1989	Smolt (trough trap)	4-29-27	6,438
	Smolt (minnow trap)	4-29-23	1,021
	Mixed (minnow trap)	4-29-26	<u>5,660</u>
		Total	13,119
1990	Smolt (trough trap)	4-26-62	11,478
	Smolt (trough trap)	4-29-31	10,540
	Smolt (trough trap)	4-31-05	1,580
	Mixed (minnow trap)	4-26-61	<u>2,781</u>
		Total	26,379
1991	Smolt (trough trap)	4-29-44	21,456
	Smolt (minnow trap)	4-31-06	1,414
	Mixed (minnow trap)	4-31-10	<u>3,669</u>
		Total	26,539
1992	Smolt (trough trap)	4-38-08	15,804
	Smolt (trough trap)	4-37-30	11,149
	Smolt (trough trap)	4-37-31	11,196
	Smolt (trough trap)	4-37-32	11,180
	Smolt (trough trap)	4-37-25	<u>3,077</u>
		Total	52,406

Table 3. Number of coho salmon coded wire tagged at Hugh Smith Lake by year, type and code, 1980–1992.

Year	Type	Code	Number Tagged
1980	Presmolt	4-20-16	5,345
1981	Smolt	4-20-18	2,777
	Presmolt	4-20-20	<u>3,737</u>
		Total	6,514
1982	Smolt	4-21-30	4,873
	Smolt	4-21-43	<u>700</u>
		Total	5,573
1983	Smolt	4-20-28	2,489
	Smolt	4-20-29	1,289
	Smolt	4-22-06	<u>5,869</u>
		Total	9,647
1984	Smolt	4-23-06	5,227
	Smolt	4-23-07	1,576
	Smolt	4-23-19	<u>9,944</u>
		Total	16,747
1985	Smolt	4-24-50	5,352
	Smolt	4-24-51	3,102
	Smolt	4-24-52	<u>1,379</u>
		Total	9,833
1986	Smolt	4-24-41	5,689
1987	Smolt	4-26-52	4,806
1988	Smolt	4-29-24	5,202
1989	Smolt	4-27-18	7,187
1990	Smolt	4-27-20	10,187
	Smolt	4-29-19	<u>919</u>
		Total	11,106
1991	Smolt	4-36-02	12,068
	Smolt	4-35-52	<u>1,201</u>
		Total	13,269
1992	Smolt	4-31-51	5,514

Table 4. Estimated harvest and percent by gear type, escapement, and total run of coho salmon returning to the Berners River, 1982, 1983, and 1985-1991.

Year	Fishery Sample Size ^a	Harvest: Number of fish and percent by gear type					Escapement	Total Run
		Troll	Purse Seine	Drift Gillnet	Sport	Total Catch		
1982	48	12,887 (41.6%)	0	10,568 (34.1%)	0	23,455 (75.7%)	7,505 (24.3%)	30,960 (100%)
1983	125	17,153 (50.4%)	0	6,978 (20.5%)	65 (0.2%)	24,196 (71.1%)	9,840 (28.9%)	34,036 (100%)
1985	93	10,865 (44.8%)	198 (0.8%)	7,015 (28.9%)	0	18,078 (74.5%)	6,169 (25.5%)	24,247 (100%)
1986	157	13,560 (55.1%)	0	8,928 (36.2%)	395 (1.6%)	22,883 (92.9%)	1,752 (7.1%)	24,635 (100%)
1987	53	7,448 ^b (53.0%)	0	3,301 (23.5%)	48 (0.3%)	10,798 (76.8%)	3,260 (23.2%)	14,058 (100%)
1988	102	5,926 (39.6%)	181 (1.2%)	6,141 (41.0%)	0	12,248 (81.8%)	2,724 (18.2%)	14,972 (100%)
1989	58	10,515 (53.4%)	0	1,664 (8.5%)	0	12,179 (61.9%)	7,509 (38.1%)	19,688 (100%)
1990	470	14,751 (43.6%)	149 (0.4%)	7,339 (21.7%)	525 (1.6%)	22,764 (67.3%)	11,050 (32.7%)	33,814 (100%)
1991	1,025	6,416 (18.3%)	578 (1.6%)	16,518 (47.0%)	117 (0.3%)	23,629 (67.2%)	11,530 (32.8%)	35,159 (100%)
Average Number of Fish		11,058	123	7,606	128	18,915	6,815	25,730
Average Percent of Total		44.4	0.4	29.1	0.5	74.4	25.6	100

^a Includes only expandable random recoveries.

^b Estimated troll catch in 1987 includes 242 fish (1.7%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 11,031 (44.2%).

Table 5. Estimated harvest and percent by gear type, escapement, and total run of coho salmon returning to Ford Arm Lake, 1982, 1983, and 1985-1991.

Year	Fishery Sample Size ^a	Harvest: Number of fish and percent by gear type				Escapement	Total Run
		Troll	Purse Seine	Drift Gillnet	Total Catch		
1982	38	1,948 (41.3%)	106 (2.3%)	0	2,054 (43.6%)	2,662 (56.4%)	4,716 (100%)
1983	93	3,412 (54.3%)	931 (14.8%)	0	4,343 (69.1%)	1,944 (30.9%)	6,287 (100%)
1985	49	2,438 (51.2%)	0	0	2,438 (51.2%)	2,324 (48.8%)	4,762 (100%)
1986	87	2,500 (60.9%)	62 (1.5%)	0	2,562 (62.4%)	1,546 (37.6%)	4,108 (100%)
1987	71	1,456 (45.1%)	79 (2.4%)	0	1,535 (47.5%)	1,694 (52.5%)	3,229 (100%)
1988	151	2,887 ^b (48.4%)	46 (0.8%)	0	2,933 (49.2%)	3,028 (50.8%)	5,961 (100%)
1989	221	3,777 (61.5%)	185 (3.0%)	0	3,962 (64.5%)	2,177 (35.5%)	6,139 (100%)
1990	174	2,979 (56.5%)	108 (2.0%)	0	3,087 (58.5%)	2,190 (41.5%)	5,277 (100%)
1991	193	3,208 (53.3%)	44 (0.7%)	10 (0.2%)	3,262 (54.2%)	2,761 (45.8%)	6,023 (100%)
Average Number of Fish		2,734	173	1	2,908	2,259	5,167
Average Percent of Total		52.5	3.1	0.0	55.6	44.4	100

^a Includes only expandable random recoveries.

^b Estimated troll catch in 1988 included 30 fish (0.5%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 2,731 (52.4%).

Table 6. Estimated harvest and percent by gear type, escapement, and total run of coho salmon returning to Hugh Smith Lake, 1982-1991.

Year	Fishery Sample Size ^a	Harvest: Number of fish and percent by gear type								Escapement	Total Run
		Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	Total Catch		
1982	91	2,780 (45.6%)	627 (10.3%)	203 (3.3%)	0	0	264 (4.3%)	78 (1.3%)	3,952 (64.8%)	2,144 (35.2%)	6,096 (100%)
1983	189	1,373 (35.4%)	424 (10.9%)	277 (7.2%)	49 (1.3%)	0	211 (5.4%)	51 (1.3%)	2,385 (61.5%)	1,490 (38.5%)	3,875 (100%)
1984	151	1,260 (31.4%)	501 (12.5%)	470 (11.7%)	18 (0.5%)	0	325 (8.1%)	28 (0.7%)	2,602 (64.9%)	1,408 (35.1%)	4,010 (100%)
1985	212	868 (36.0%)	287 (11.9%)	137 (5.7%)	5 (0.2%)	0	199 (8.3%)	13 (0.5%)	1,509 (62.6%)	903 (37.4%)	2,412 (100%)
1986	257	1,585 (35.4%)	515 (11.5%)	315 (7.0%)	2 (0.1%)	14 (0.3%)	234 (5.2%)	26 (0.6%)	2,691 (60.1%)	1,783 (39.9%)	4,474 (100%)
1987	100	656 (28.0%)	95 (4.1%)	249 (10.6%)	0	23 (1.0%)	153 (6.5%)	50 (2.1%)	1,226 (52.3%)	1,118 (47.7%)	2,344 (100%)
1988	42	408 (26.7%)	230 (15.0%)	122 (8.0%)	0	0	234 (15.3%)	23 (1.5%)	1,017 (66.5%)	513 (33.5%)	1,530 (100%)
1989	91	1,213 (50.0%)	375 (15.5%)	237 (9.8%)	0	41 (1.7%)	105 (4.3%)	20 (0.8%)	1,991 (82.1%)	433 (17.9%)	2,424 (100%)
1990	263	1,810 (39.4%)	538 (11.7%)	504 (11.0%)	24 (0.5%)	0	794 (17.3%)	53 (1.2%)	3,723 (81.1%)	870 (18.9%)	4,593 (100%)
1991	408	2,102 (36.7%)	195 (3.4%)	881 (15.4%)	0	54 (0.9%)	630 (11.0%)	43 (0.7%)	3,905 (68.1%)	1,826 (31.9%)	5,731 (100%)
Average Number of Fish		1,405	379	340	10	13	315	38	2,500	1,249	3,749
Average Percent of Total		36.4	10.7	9.0	0.2	0.4	8.6	1.1	66.4	33.4	100

^a Includes only expandable random recoveries.

Table 7. Overall coho salmon harvest rates by indicator stock for the Alaska troll fishery and all fisheries combined, 1982-1991.

Year	Berners River	Ford Arm Lake	Hugh Smith Lake	Average
Alaska Troll Fishery:				
1982	41.6	41.3	45.6	42.8
1983	50.4	54.3	35.4	46.7
1984			31.4	38.8
1985	44.8	51.2	36.0	44.0
1986	55.1	60.9	35.4	50.5
1987	51.3	45.1	28.0	41.5
1988	39.6	47.9	26.7	38.1
1989	53.4	61.5	50.0	55.0
1990	43.6	56.5	39.4	46.5
1991	18.3	53.3	36.7	36.1
Average	44.2	52.4	36.5	44.0
All Fisheries:				
1982	75.7	43.6	64.8	61.4
1983	71.1	69.1	61.5	67.2
1984			64.9	64.4
1985	74.5	51.2	62.6	62.8
1986	92.9	62.4	60.1	71.8
1987	76.8	47.5	52.3	58.9
1988	81.8	49.2	66.5	65.8
1989	61.9	64.5	82.1	69.5
1990	67.3	58.5	81.1	69.0
1991	67.2	54.2	68.1	63.2
Average	74.4	55.6	66.4	65.4

Table 8. Estimated coho salmon coho salmon removal rate by fishery for the Berners River run, 1982, 1983, and 1985-1991.

Year	Troll and Purse Seine	Marine Sport	115 Gillnet	Gillnet and Sport Total	Grand Total
1982	0.416	0	0.585	0.585	0.757
1983	0.504	0.004	0.415	0.417	0.711
1985	0.456	0	0.532	0.532	0.745
1986	0.551	0.036	0.836	0.842	0.929
1987	0.530	0.007	0.503	0.507	0.768
1988	0.408	0	0.693	0.693	0.818
1989	0.534	0	0.155	0.182	0.619
1990	0.440	0.029	0.387	0.415	0.673
1991	0.199	0.004	0.587	0.591	0.672
Average	0.449	0.009	0.521	0.529	0.744

Table 9. Estimated coho salmon removal rate by area for the Hugh Smith Lake run, 1982-1991.

Year	Outside and Intermediate	Northern B.C.	Total	Inside ^a	Grand Total
1982	0.381	0.056	0.437	0.375	0.648
1983	0.289	0.067	0.356	0.403	0.615
1984	0.302	0.088	0.390	0.424	0.649
1985	0.318	0.088	0.406	0.370	0.626
1986	0.382	0.058	0.440	0.288	0.601
1987	0.279	0.087	0.366	0.247	0.523
1988	0.343	0.168	0.511	0.314	0.665
1989	0.458	0.051	0.509	0.636	0.821
1990	0.366	0.185	0.551	0.579	0.811
1991	0.299	0.117	0.416	0.454	0.681
Average	0.342	0.096	0.438	0.409	0.664

^a Inside area includes Districts 101, 102, 105, 106, 107 and 108.

Table 10. Estimated harvest as a percentage of total harvest for Berners River coho salmon by area and gear type, 1982, 1983 and 1985-1991.

Area	Gear Type	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
N. Outside	Troll	20.3	29.6	18.3	28.4	16.9	20.3	24.8	25.2	3.4	20.8
C. Outside	Troll	3.7	11.7	15.5	15.7	13.9	2.1	11.9	8.4	4.9	9.8
S. Outside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.1
	Seine	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>1.5</u>	<u>0.0</u>	<u>0.2</u>	<u>0.1</u>	<u>0.2</u>
	Total	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.0	0.3	0.3
C. Intermed.	Troll	35.6	26.9	23.3	7.7	22.9	25.9	48.8	26.9	18.1	26.2
	Seine	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.4	0.8	0.3
	Sport	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.2</u>	<u>0.0</u>	<u>0.0</u>
	Total	35.6	26.9	24.5	7.7	22.9	25.9	48.8	27.5	18.9	26.5
S. Intermed.	Troll	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.2	0.3	0.4
	Seine	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.1</u>	<u>1.5</u>	<u>0.2</u>
	Total	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.3	1.8	0.6
C. Inside	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1
S. Inside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Lynn Canal	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
	Gillnet	<u>40.4</u>	<u>30.5</u>	<u>41.7</u>	<u>44.7</u>	<u>42.6</u>	<u>50.2</u>	<u>11.9</u>	<u>32.3</u>	<u>69.5</u>	<u>40.4</u>
	Total	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.7	69.5	40.5
Steph. Pass.	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.3	0.5	0.5
	Sport	<u>0.0</u>	<u>0.3</u>	<u>0.0</u>	<u>2.0</u>	<u>0.6</u>	<u>0.0</u>	<u>0.0</u>	<u>2.2</u>	<u>0.5</u>	<u>0.6</u>
	Total	0.0	0.3	0.0	2.0	0.6	0.0	2.6	3.5	1.0	1.1
Northern B.C.	Troll	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.3
Grand Total		100	100	100	100	100	100	100	100	100	100
Sample Size (Tags)		40	98	81	122	32	103	48	387	1,002	

Table 11. Estimated harvest distribution as a percentage of total harvest for Ford Arm Lake coho salmon by area and gear type, 1982, 1983 and 1985-1991.

Area	Gear Type	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Northern Outside	Troll	9.4	19.2	15.3	4.9	24.0	29.5	31.2	27.7	9.3	19.0
Central Outside	Troll	62.4	51.0	84.7	88.0	55.8	61.8	55.9	63.0	81.8	67.1
	Seine	<u>0.0</u>	<u>23.0</u>	<u>0.0</u>	<u>0.7</u>	<u>6.8</u>	<u>0.0</u>	<u>5.9</u>	<u>3.3</u>	<u>1.4</u>	<u>4.6</u>
	Total	62.4	74.0	84.7	88.7	62.6	61.8	61.8	66.3	83.2	71.7
Southern Outside	Troll	5.3	1.0	0.0	1.2	0.0	0.0	0.0	0.0	1.6	1.0
	Seine	<u>5.0</u>	<u>0.0</u>	<u>0.0</u>	<u>1.9</u>	<u>0.0</u>	<u>1.6</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>1.0</u>
	Total	10.3	1.0	0.0	3.1	0.0	1.6	0.0	0.0	1.6	2.0
Central Intermediate	Troll	13.0	5.8	0.0	1.3	13.4	5.5	6.4	5.5	4.9	6.2
	Seine	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.5</u>	<u>0.0</u>	<u>0.1</u>
	Total	13.0	5.8	0.0	1.3	13.4	5.5	6.4	6.0	4.9	6.3
Southern Intermediate	Troll	0.0	0.0	0.0	2.0	0.0	0.5	0.6	0.0	0.7	0.4
Central Inside	Troll	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Northern B.C.	Troll	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.1
Grand Total		100	100	100	100	100	100	100	100	100	100
Sample Size		31	71	31	65	49	132	157	134	157	

Table 12. Estimated harvest distribution as a percentage of total harvest for Hugh Smith Lake coho salmon by area and gear type, 1982-1991.

Area	Gear Type	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Northern Outside	Troll	0.0	8.0	5.6	5.8	2.7	3.3	6.7	0.0	6.1	2.9	4.1
Central Outside	Troll	30.2	21.6	19.8	33.0	37.9	11.3	23.8	31.2	22.9	21.6	25.3
	Seine	<u>0.0</u>	<u>0.4</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
	Total	30.2	22.0	19.8	33.0	37.9	11.3	23.8	31.2	22.9	21.6	25.3
Southern Outside	Troll	11.1	10.0	7.0	8.6	5.7	22.6	5.6	12.2	7.3	12.4	10.3
	Seine	<u>5.2</u>	<u>3.0</u>	<u>8.7</u>	<u>3.0</u>	<u>11.5</u>	<u>5.6</u>	<u>17.1</u>	<u>9.5</u>	<u>6.2</u>	<u>4.0</u>	<u>7.4</u>
	Total	16.3	13.0	15.7	11.6	17.2	28.2	22.7	21.7	13.5	16.4	17.7
Central Intermediate	Troll	1.4	2.2	6.9	0.0	2.7	1.2	0.0	1.0	0.0	1.2	1.7
Southern Intermediate	Troll	10.7	4.4	0.7	2.8	3.9	9.9	3.3	6.9	5.5	5.5	5.4
	Seine	<u>0.0</u>	<u>0.0</u>	<u>0.5</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.3</u>	<u>0.0</u>	<u>0.1</u>
	Total	10.7	4.4	1.2	2.8	3.9	9.9	3.3	6.9	5.8	5.5	5.4
Central Inside	Troll	0.3	2.9	1.2	0.7	1.1	0.0	0.0	5.6	1.2	0.2	1.3
	Seine	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Gillnet	<u>0.0</u>	<u>5.5</u>	<u>0.6</u>	<u>0.3</u>	<u>3.2</u>	<u>0.0</u>	<u>0.0</u>	<u>4.2</u>	<u>3.1</u>	<u>6.9</u>	<u>2.4</u>
	Total	0.3	9.0	1.8	1.0	4.3	0.0	0.0	9.8	4.3	7.1	3.8
Southern Inside	Troll	14.7	9.0	9.4	7.2	4.4	6.0	5.1	5.1	5.5	7.6	7.4
	Seine	11.7	13.6	9.2	15.8	7.9	2.0	3.9	8.8	8.0	1.2	8.2
	Gillnet	5.5	6.0	16.7	8.6	8.6	20.0	11.1	7.4	10.5	16.7	11.1
	Trap	0.0	2.0	0.7	0.4	0.1	0.0	0.0	0.0	0.6	0.0	0.4
	Sport	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.5</u>	<u>1.8</u>	<u>0.0</u>	<u>2.0</u>	<u>0.0</u>	<u>1.5</u>	<u>0.6</u>
	Total	31.9	30.6	36.0	32.0	21.5	29.8	20.1	23.3	24.6	27.0	27.7
Northern B.C.	Troll	7.1	8.7	12.0	13.0	8.8	12.3	21.3	5.1	21.4	17.0	12.7
	Net	<u>2.1</u>	<u>2.1</u>	<u>1.0</u>	<u>0.8</u>	<u>1.0</u>	<u>4.0</u>	<u>2.1</u>	<u>1.0</u>	<u>1.4</u>	<u>1.2</u>	<u>1.7</u>
	Total	9.2	10.8	13.0	13.8	9.8	16.3	23.4	6.1	22.8	18.2	14.3
Grand Total		100	100	100	100	100	100	100	100	100	100	100
Sample Size		83	175	143	196	228	99	42	92	258	335	

Table 13. Estimated harvest distribution by quadrant as a percentage of the total Alaska troll harvest for Berners River, Ford Arm Lake and Hugh Smith Lake coho salmon, 1982-1991.

Year	Northwest	Northeast	Southwest	Southeast	Total	Number of Recoveries
Berners River:						
1982	100.0	0.0	0.0	0.0	100	25
1983	97.0	3.0	0.0	0.0	100	77
1985	100.0	0.0	0.0	0.0	100	50
1986	96.6	3.4	0.0	0.0	100	87
1987	96.4	3.6	0.0	0.0	100	43
1988	97.6	2.4	0.0	0.0	100	64
1989	97.4	2.6	0.0	0.0	100	49
1990	93.9	5.0	1.1	0.0	100	303
1991	94.0	4.9	0.7	0.4	100	325
Average	97.0	2.8	0.2	0.0	100	114
Ford Arm Lake:						
1982	91.3	0.0	5.8	2.9	100	37
1983	98.8	0.0	1.2	0.0	100	83
1985	100.0	0.0	0.0	0.0	100	49
1986	97.0	1.8	1.2	0.0	100	85
1987	100.0	0.0	0.0	0.0	100	65
1988	99.5	0.5	0.0	0.0	100	148
1989	99.5	0.5	0.0	0.0	100	206
1990	100.0	0.0	0.0	0.0	100	134
1991	98.0	0.5	1.5	0.0	100	191
Average	98.2	0.4	1.1	0.3	100	111
Hugh Smith Lake:						
1982	47.0	14.8	14.8	23.3	100	64
1983	52.1	5.6	17.6	24.6	100	107
1984	59.7	1.3	15.1	23.8	100	67
1985	65.5	2.4	15.2	16.9	100	114
1986	73.9	5.2	9.5	11.4	100	155
1987	31.8	14.8	42.8	10.7	100	52
1988	68.2	0.0	15.6	16.3	100	22
1989	48.4	6.1	20.9	24.6	100	61
1990	55.3	8.3	15.8	20.6	100	123
1991	47.6	4.9	21.7	25.8	100	210
Average	55.0	6.3	18.9	19.8	100	98

Table 14. Estimated survival rates of predominantly age-1 and older wild coho salmon presmolts and smolts from the time of tagging until entry into the coastal fisheries, 1980-1990.

Year Tagged	Berners River Presmolts	Berners River Smolts	Ford Arm Lake Presmolts	Hugh Smith Lake Smolts
1980	2.9	-	6.3	-
1981	6.7	-	9.6	-
1982	-	-	-	13.3
1983	5.9	-	14.4	7.4
1984	5.1	-	10.2	7.5
1985	3.2	-	6.0	19.1
1986	5.3	-	7.0	10.6
1987	4.3	-	12.7	4.2
1988	8.8	-	10.3	6.0
1989	-	19.8	-	17.5
1990	-	24.8	-	17.4
Average	5.3	22.3	9.6	11.4

Table 15. Hugh Smith Lake coho salmon smolt counts at the weir and total smolt estimates, 1983-1990.

Year	Smolt Weir Count	Number Marked (M)	Returns Sampled (C)	Adipose Clips (R)	Smolt Estimate (N)	Variance	95% C.I. Lower Bound	95% C.I. Upper Bound
1983	27,552	9,647	1,239	230	51,789	9182285	45,850	57,728
1984	22,803	16,928	805	424	32,104	1115047	30,035	34,174
1985	11,111	9,833	692	289	23,499	1071050	21,470	25,527
1986	6,819	5,716	508	132	21,878	2577574	18,732	25,025
1987	4,965	4,819	262	34	36,218	31360356	25,242	47,194
1988	5,319	5,292	290	65	23,336	6206793	18,453	28,219
1989	7,187	7,187	736	198	26,620	2514993	23,512	29,728
1990	11,106	11,106	1,582	533	32,925	1278248	30,709	35,141
Average	12,108	8,816	764	238	31,046			

Table 16. Estimated age composition proportions for Hugh Smith Lake coho salmon smolts, 1983-1991.

Year	Age					Sample Size
	1	2	3	4	5	
1983	0.2230	0.4951	0.2820	0.0000	0.0000	305
1984	0.1227	0.5242	0.3457	0.0074	0.0000	269
1985	0.1794	0.6088	0.2118	0.0000	0.0000	340
1986	0.1601	0.5850	0.2549	0.0000	0.0000	306
1987	0.0575	0.6150	0.3274	0.0000	0.0000	452
1988	0.1610	0.7123	0.1254	0.0014	0.0000	702
1989	0.2603	0.4960	0.2112	0.0297	0.0029	853
1990	0.0466	0.7336	0.1981	0.0201	0.0017	782
1991	0.0873	0.6740	0.2193	0.0194	0.0000	562
Average	0.1442	0.6049	0.2417	0.0087	0.0005	

Table 17. Estimated coho salmon smolt migration from Hugh Smith Lake by age class, 1983-1990.

Year	Age					Total
	1	2	3	4	5	
1983	11,546	25,640	14,603	0	0	51,789
1984	3,938	16,828	11,099	239	0	32,104
1985	4,216	14,307	4,976	0	0	23,499
1986	3,503	12,798	5,577	0	0	21,878
1987	2,083	22,276	11,859	0	0	36,218
1988	3,756	16,621	2,925	33	0	23,336
1989	6,928	13,203	5,623	789	77	26,620
1990	1,534	24,155	6,521	660	55	32,925
Avg.	4,688	18,228	7,898	215	16	31,046

Table 18. Estimated numbers of Hugh Smith Lake coho salmon smolts emigrating from specific parent escapements and brood years, 1981-1990.

Brood Year	Parent-year Escapement	Age					Total
		1	2	3	4	5	
1981		11,546	16,828	4,976	0	0	33,351
1982	2,144	3,938	14,307	5,577	0	0	23,822
1983	1,490	4,216	12,798	11,859	33	77	28,983
1984	1,408	3,503	22,276	2,925	789	55	29,548
1985	903	2,083	16,621	5,623	660		24,988
1986	1,783	3,756	13,203	6,521			23,480
1987	1,118	6,928	24,155				
1988	513	1,534					
1989	424						
1990	870						
1991	1,826						

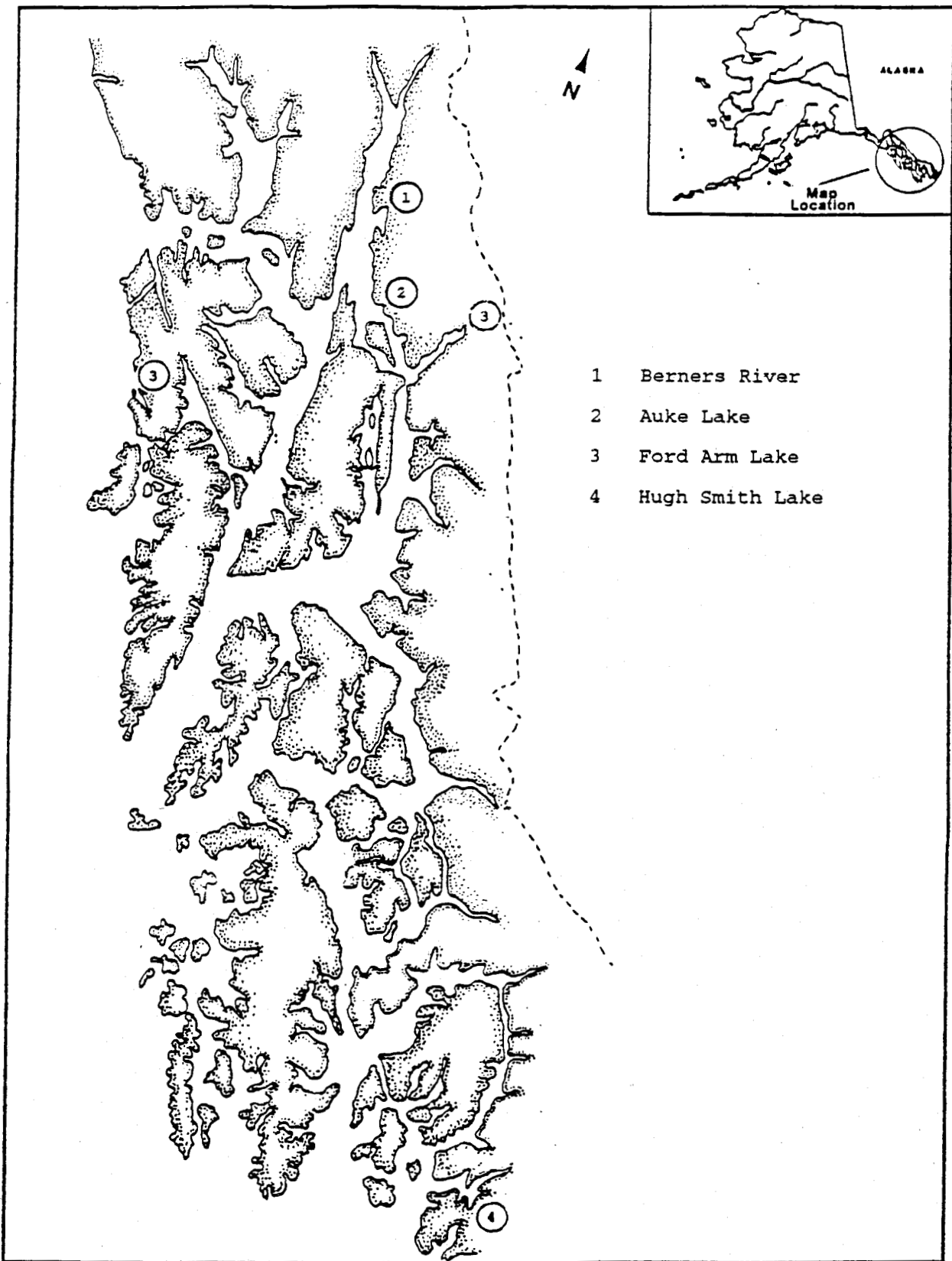


Figure 1. Locations of wild coho salmon indicator stocks in Southeast Alaska.

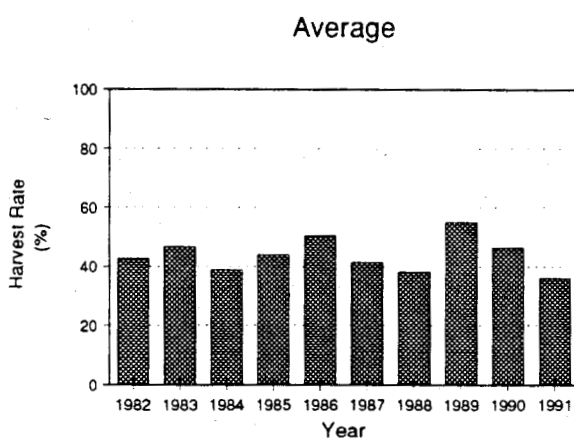
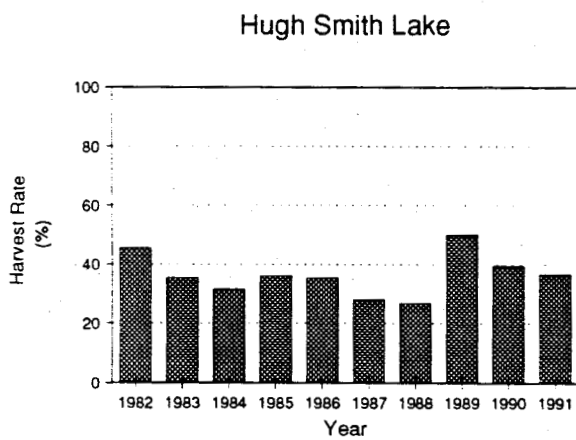
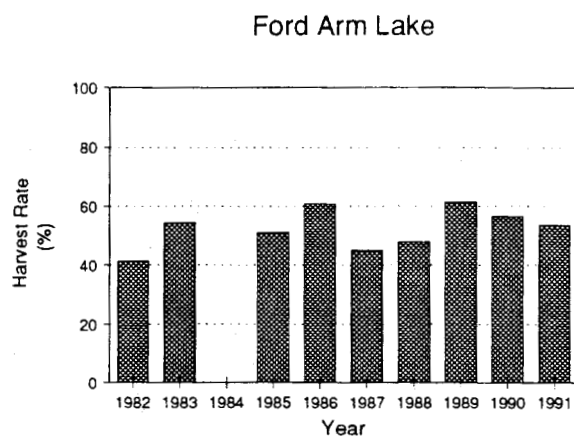
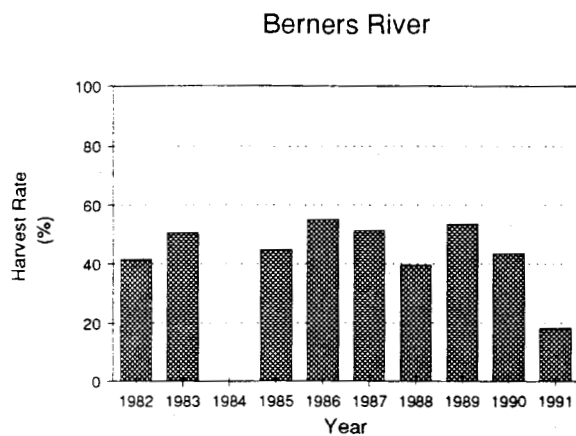


Figure 2. Alaska troll fishery harvest rates estimated for three Southeast Alaska indicator coho salmon indicator stocks, 1982-1991.

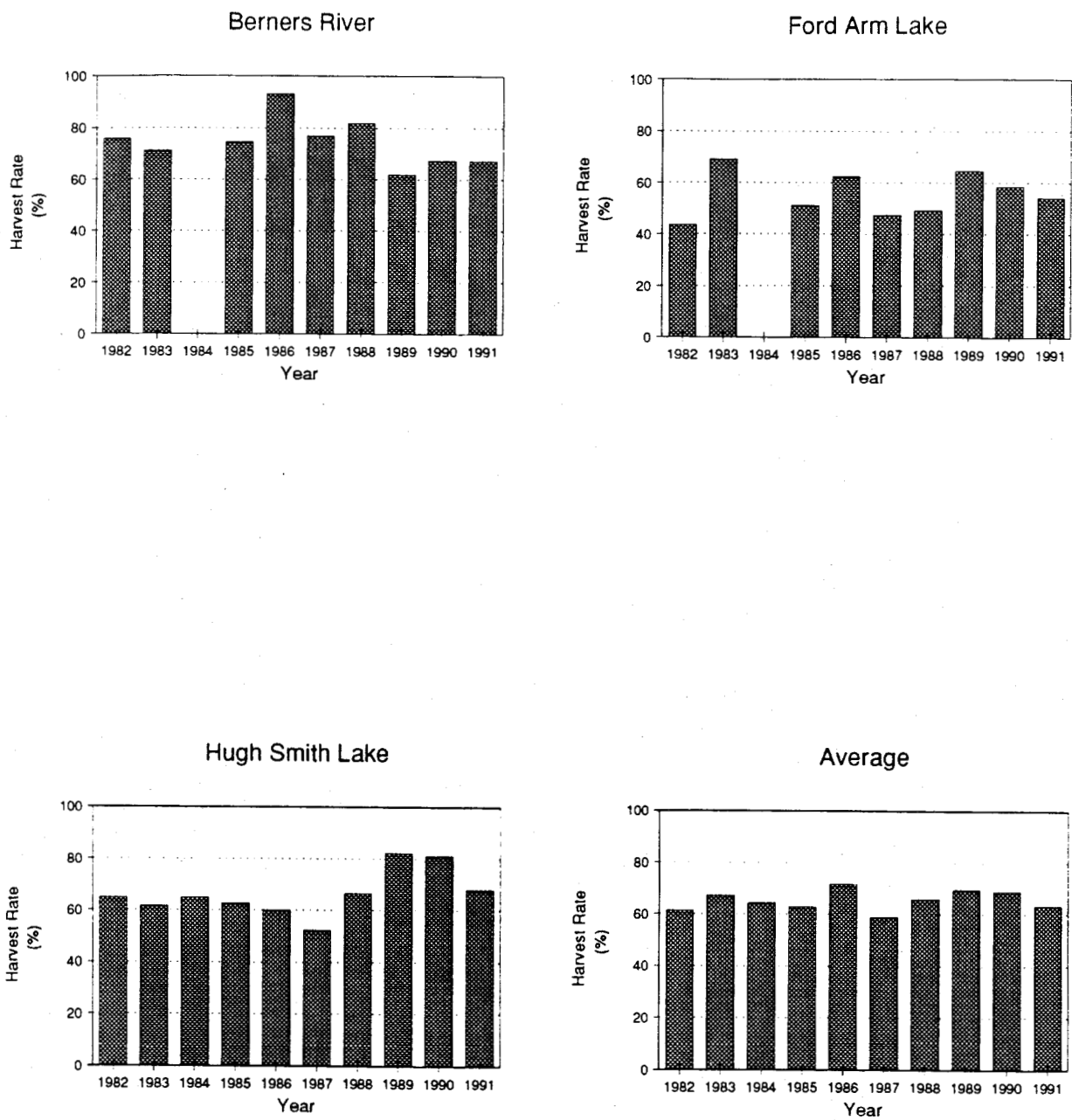


Figure 3. Harvest rates by all fisheries estimated for three Southeast Alaska coho salmon indicator stocks, 1982-1991.

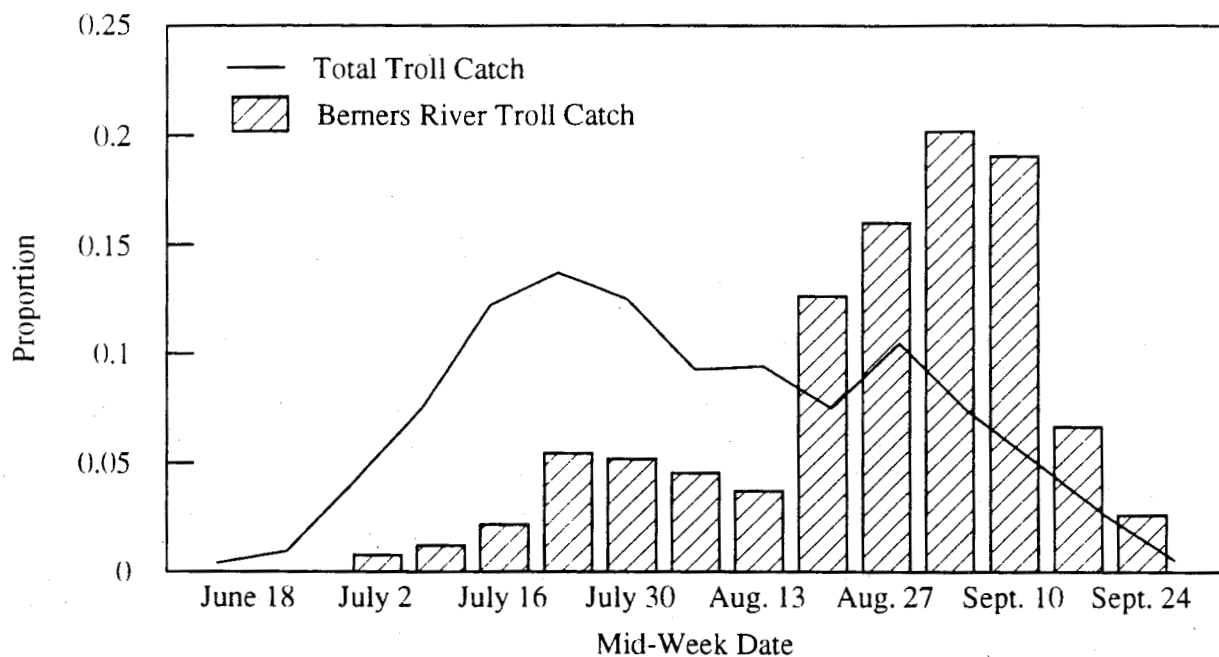


Figure 4. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Berners River coho salmon, averaged for 1982, 1983 and 1985-1991.

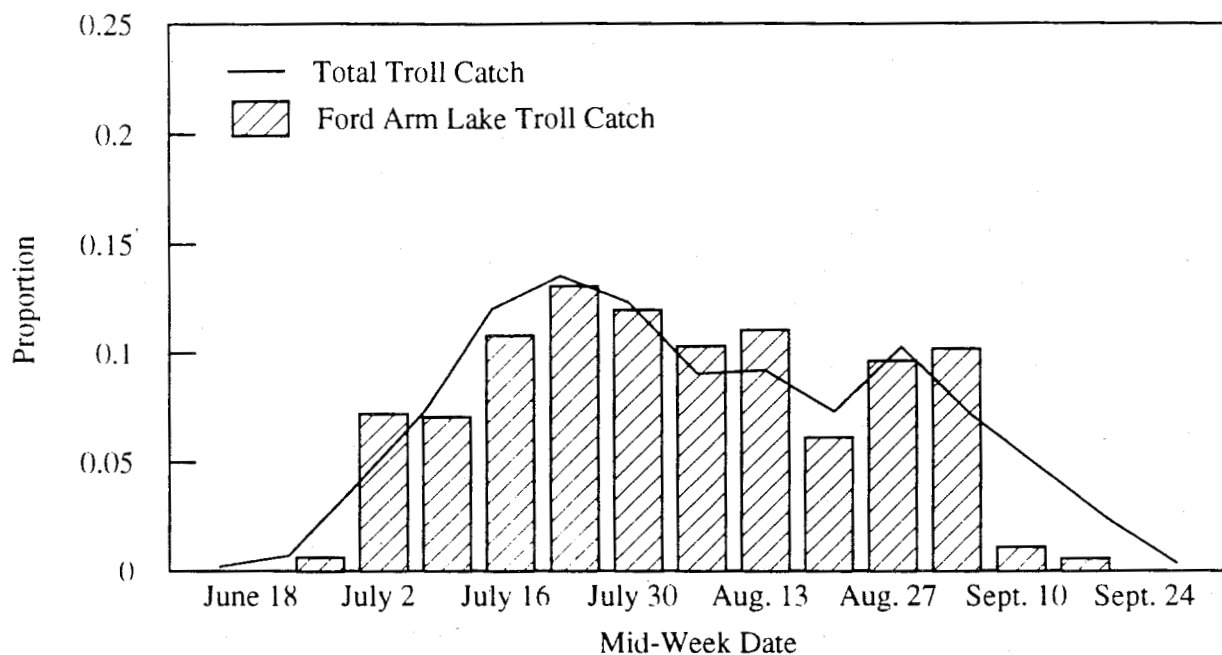


Figure 5. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Ford Arm Lake coho salmon, averaged for 1982, 1983 and 1985-1991.

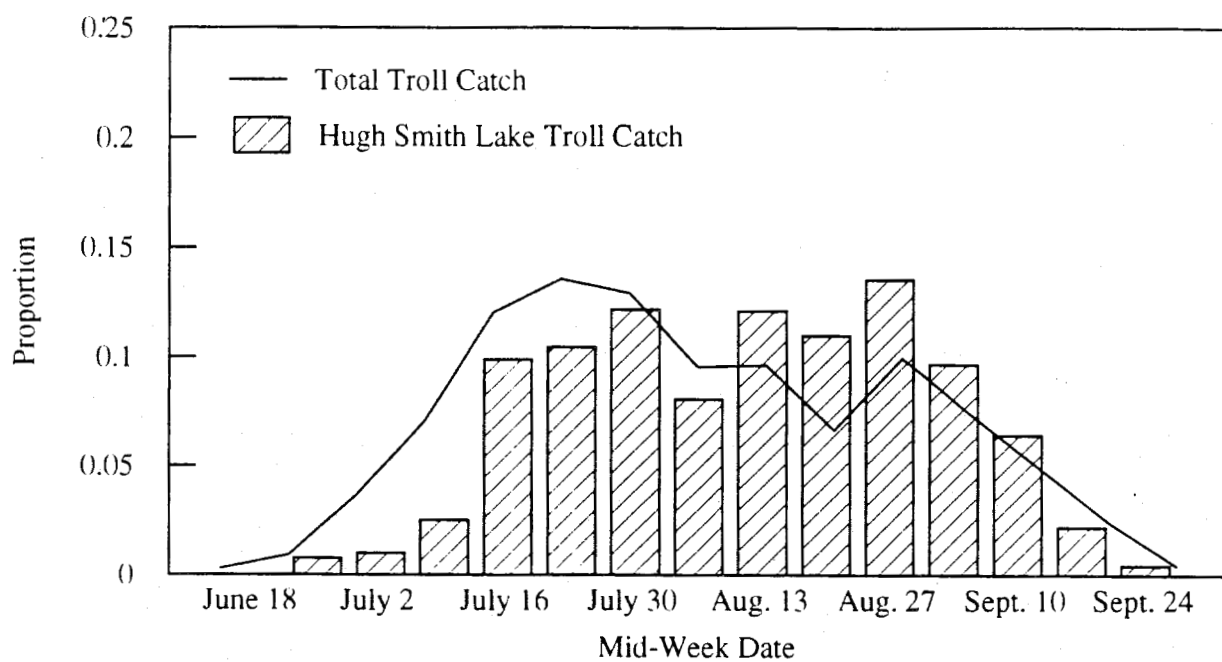


Figure 6. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Hugh Smith Lake coho salmon, averaged for 1982-1991.

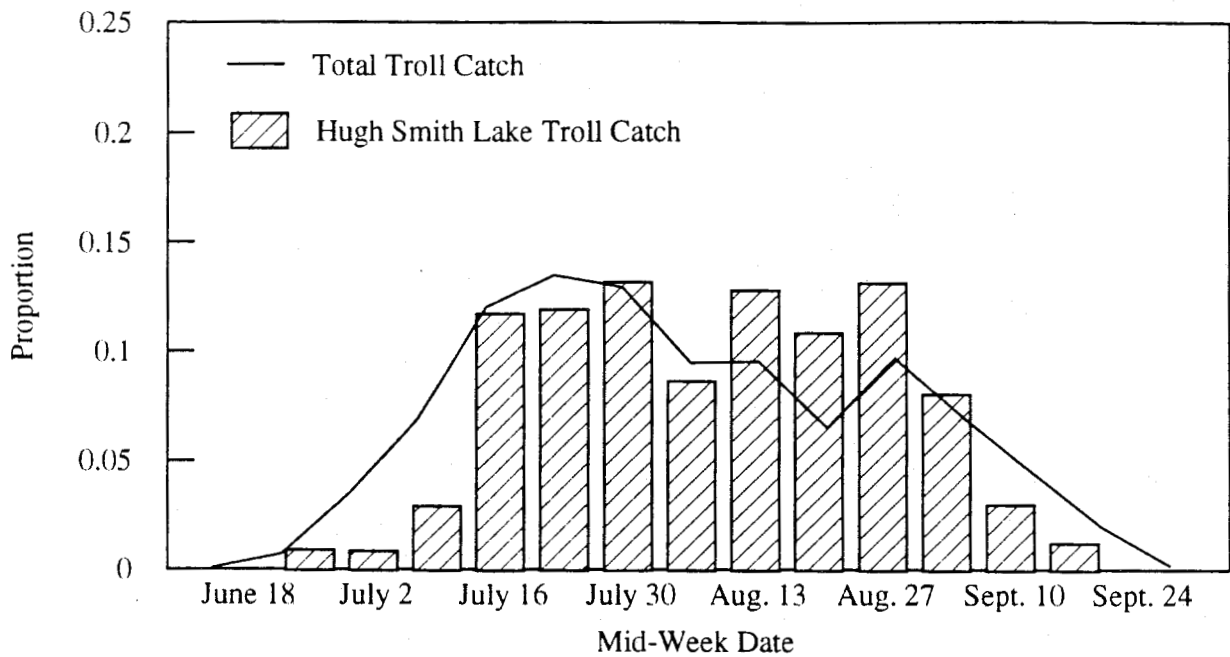


Figure 7. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Hugh Smith Lake coho salmon in the Northwest, Northeast and Southwest Quadrants, averaged for 1982-1991.

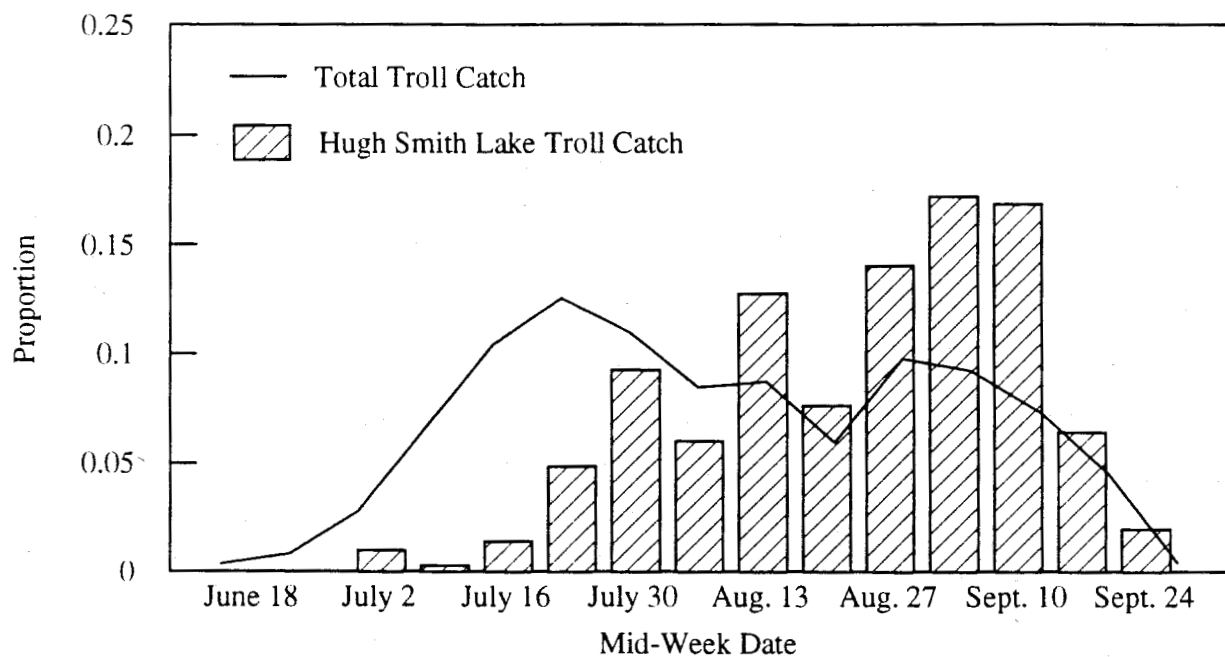
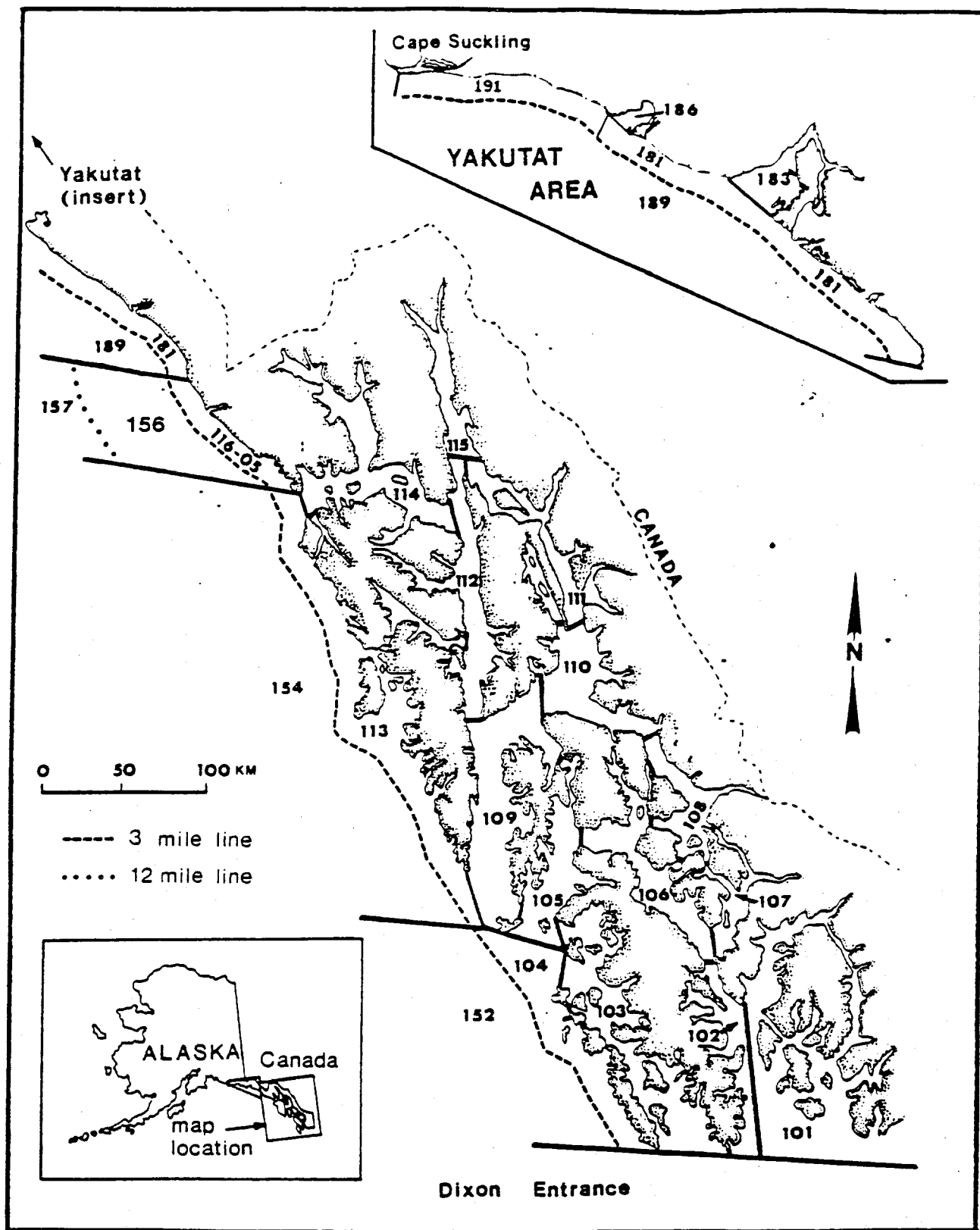


Figure 8. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Hugh Smith Lake coho salmon in the Southeast Quadrant, averaged for 1982-1991.

APPENDIX



Appendix A.1. Southeast Alaska statistical fishing districts.

Appendix A.2. Statistical areas of Southeast Alaska within Pacific Marine Fisheries Commission (PMFC) areas and quadrants.

PMFC Area	Abbreviation	Statistical Areas (Districts)
Northern Outside	NOUT	116, 156, 157, 181, 183, 189, 191
Central Outside	COUT	113, 154
Southern Outside	SOUT	103, 104, 152
Southern Inside	SIN	101, 102, 150
Southern Intermediate	SNTR	105, 109, 110
Central Inside	CIN	106, 107, 108
Stephens Passage	STEP	111
Central Intermediate	CNTR	112, 114
Lynn Canal	LYNN	115
Quadrant	Abbreviation	Statistical Areas (Districts)
Northwest	NW	113, 114, 116, 154, 156, 157, 181, 183, 186, 189, 191
Northeast	NE	109, 110, 111, 112, 115
Southwest	SW	103, 104, 150, 152
Southeast	SE	101, 102, 105, 106, 107, 108

Appendix B.1. Estimated weekly proportions of the total troll catch of Berners River coho salmon, 1982, 1983 and 1985-1991.

Stat. Week	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0000	0.0000	0.0000	0.0647	0.0000	0.0000	0.0000	0.0000	0.0047	0.0077
28	0.0000	0.0193	0.0370	0.0199	0.0000	0.0000	0.0000	0.0269	0.0033	0.0118
29	0.0000	0.0000	0.0000	0.1329	0.0000	0.0000	0.0000	0.0354	0.0267	0.0217
30	0.0244	0.0761	0.1039	0.0791	0.1037	0.0167	0.0313	0.0173	0.0349	0.0542
31	0.0486	0.0566	0.0664	0.0245	0.1108	0.0000	0.0509	0.0547	0.0524	0.0517
32	0.0000	0.0832	0.0377	0.0592	0.0513	0.0000	0.0538	0.0723	0.0491	0.0452
33	0.0952	0.0000	0.0000	0.0181	0.0000	0.0869	0.0484	0.0434	0.0426	0.0372
34	0.3578	0.2010	0.0000	0.1107	0.2010	0.0684	0.0619	0.1346	0.0000	0.1262
35	0.0985	0.1663	0.1227	0.1585	0.0323	0.1664	0.3296	0.2301	0.1341	0.1598
36	0.0000	0.1655	0.3482	0.2243	0.2880	0.3805	0.1329	0.1555	0.1204	0.2017
37	0.1449	0.1165	0.2380	0.1081	0.1839	0.2449	0.2342	0.1923	0.2511	0.1904
38	0.0000	0.1155	0.0461	0.0000	0.0290	0.0329	0.0570	0.0375	0.2807	0.0665
39	0.2306	0.0000	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0000	0.0260
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	25	77	50	87	43	63	49	303	325	

Appendix B.2. Estimated weekly proportions of the total troll catch of Ford Arm Lake coho salmon, 1982, 1983 and 1985-1991.

Stat. Week	1982	1983	1985	1986	1987	1988	1989	1990	1991	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0106	0.0484	0.0000	0.0000	0.0000	0.0000	0.0066
27	0.0000	0.0000	0.4280	0.1164	0.0613	0.0092	0.0071	0.0000	0.0299	0.0724
28	0.0000	0.1662	0.0429	0.1967	0.0682	0.0278	0.0000	0.0923	0.0456	0.0711
29	0.1584	0.1326	0.0205	0.1584	0.0843	0.0608	0.0520	0.1765	0.1315	0.1083
30	0.0844	0.1376	0.0752	0.1347	0.1918	0.1081	0.1084	0.0737	0.2636	0.1308
31	0.1006	0.1775	0.0385	0.0828	0.1094	0.0278	0.1209	0.1994	0.2229	0.1200
32	0.0000	0.1025	0.0546	0.1558	0.1500	0.0000	0.1899	0.2116	0.0660	0.1034
33	0.2394	0.0157	0.1003	0.0611	0.0509	0.1464	0.1044	0.1332	0.1445	0.1107
34	0.1235	0.0895	0.0000	0.0000	0.1208	0.1496	0.0669	0.0000	0.0000	0.0611
35	0.1020	0.0991	0.1660	0.0297	0.0955	0.0000	0.2455	0.0981	0.0329	0.0965
36	0.1917	0.0567	0.0673	0.0538	0.0194	0.4212	0.0746	0.0000	0.0334	0.1020
37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0450	0.0156	0.0152	0.0258	0.0113
38	0.0000	0.0226	0.0067	0.0000	0.0000	0.0041	0.0148	0.0000	0.0039	0.0058
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	37	83	49	85	65	148	206	156	188	

Appendix B.3. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon, 1982-1991.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0030	0.0000
26	0.0000	0.0000	0.0402	0.0000	0.0000	0.0276	0.0000	0.0000	0.0000	0.0000	0.0075
27	0.0085	0.0000	0.0000	0.0000	0.0073	0.0183	0.0000	0.0229	0.0310	0.0074	0.0098
28	0.0000	0.0415	0.0000	0.0492	0.0723	0.0000	0.0000	0.0000	0.0608	0.0279	0.0249
29	0.1134	0.0867	0.0655	0.1351	0.1081	0.1910	0.0000	0.0379	0.1511	0.1410	0.0988
30	0.0628	0.1481	0.0000	0.1689	0.1246	0.0430	0.0573	0.2477	0.0871	0.0912	0.1044
31	0.0950	0.1010	0.2028	0.1394	0.1216	0.1554	0.0474	0.0788	0.1531	0.1197	0.1216
32	0.0000	0.1224	0.1365	0.0713	0.1217	0.0924	0.0000	0.0631	0.1175	0.1012	0.0805
33	0.2632	0.0154	0.1014	0.1189	0.0553	0.0000	0.2941	0.1359	0.1052	0.1087	0.1210
34	0.1111	0.2405	0.0000	0.0000	0.1007	0.2527	0.1498	0.0632	0.0677	0.0000	0.1095
35	0.2396	0.0745	0.0764	0.1498	0.1378	0.1152	0.1156	0.1872	0.1216	0.1147	0.1353
36	0.0481	0.0626	0.1317	0.0747	0.0794	0.0863	0.3358	0.0205	0.0279	0.0787	0.0963
37	0.0170	0.0686	0.1871	0.0521	0.0284	0.0181	0.0000	0.1428	0.0631	0.1310	0.0641
38	0.0055	0.0348	0.0584	0.0406	0.0428	0.0000	0.0000	0.0000	0.0139	0.0755	0.0218
39	0.0358	0.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	64	107	67	114	155	52	22	61	120	209	

Appendix B.4. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon in the Northwest, Northeast and Southwest Quadrants combined, 1982–1991.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0534	0.0000	0.0000	0.0310	0.0000	0.0000	0.0000	0.0000	0.0094
27	0.0000	0.0000	0.0000	0.0000	0.0084	0.0205	0.0000	0.0128	0.0395	0.0099	0.0090
28	0.0000	0.0556	0.0000	0.0601	0.0827	0.0000	0.0000	0.0000	0.0694	0.0373	0.0298
29	0.1453	0.1084	0.0871	0.1515	0.1236	0.2139	0.0000	0.0511	0.1801	0.1886	0.1179
30	0.0735	0.1800	0.0000	0.2001	0.1424	0.0320	0.0705	0.2856	0.0956	0.1143	0.1200
31	0.0861	0.1144	0.2695	0.1310	0.1276	0.1394	0.0583	0.0763	0.1902	0.1464	0.1325
32	0.0000	0.1322	0.1814	0.0516	0.1285	0.0898	0.0000	0.0498	0.1494	0.1294	0.0870
33	0.2845	0.0207	0.1348	0.1147	0.0528	0.0000	0.3070	0.1215	0.1217	0.1092	0.1286
34	0.1229	0.2301	0.0000	0.0000	0.1151	0.2477	0.1449	0.0852	0.0372	0.0000	0.1092
35	0.2728	0.0562	0.0000	0.1470	0.1239	0.1291	0.1423	0.2344	0.0839	0.1004	0.1322
36	0.0149	0.0593	0.1263	0.0748	0.0673	0.0966	0.2770	0.0151	0.0000	0.0425	0.0813
37	0.0000	0.0231	0.1062	0.0359	0.0147	0.0000	0.0000	0.0681	0.0260	0.1018	0.0305
38	0.0000	0.0200	0.0413	0.0333	0.0130	0.0000	0.0000	0.0000	0.0071	0.0203	0.0127
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	44	73	44	87	128	45	18	44	96	165	

Appendix B.5. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon in the Southeast Quadrant, 1982-1991.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0117	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0517	0.0000	0.0000	0.0100
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0293	0.0000	0.0033
29	0.0000	0.0227	0.0000	0.0614	0.0000	0.0000	0.0000	0.0000	0.0449	0.0000	0.0143
30	0.0250	0.0542	0.0000	0.0292	0.0000	0.1350	0.0000	0.1391	0.0561	0.0230	0.0487
31	0.1266	0.0613	0.0000	0.1771	0.0797	0.2883	0.0000	0.0859	0.0169	0.0407	0.0929
32	0.0000	0.0934	0.0000	0.1595	0.0735	0.1139	0.0000	0.1013	0.0000	0.0175	0.0602
33	0.1874	0.0000	0.0000	0.1377	0.0730	0.2940	0.2384	0.1770	0.0448	0.1075	0.1280
34	0.0692	0.2711	0.0000	0.0000	0.0000	0.0000	0.1709	0.0000	0.1797	0.0000	0.0768
35	0.1213	0.1284	0.3086	0.1622	0.2347	0.0000	0.0000	0.0519	0.2600	0.1570	0.1408
36	0.1659	0.0723	0.1483	0.0745	0.1638	0.1688	0.5907	0.0359	0.1303	0.1859	0.1723
37	0.0774	0.2026	0.4327	0.1247	0.1243	0.0000	0.0000	0.3572	0.1992	0.2177	0.1687
38	0.0253	0.0784	0.1104	0.0737	0.2510	0.0000	0.0000	0.0000	0.0387	0.2390	0.0642
39	0.1633	0.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0199
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	20	34	23	27	27	7	4	17	24	44	

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